The Journal of Occupational Diseases and Traumatic Surgery

Industrial Medicine

for

Physicians and Surgeons in Industry

Volume 6 JUNE, 1937 Number 6

Pulmonary Embolism

Fractures of the Spine

Treatment of Wounds

Occupational Dermatoses

Medicine in a Changing Era

Industrial Gases and Vapors

Injection Treatment of Hernia

Industrial Hygiene Laboratories

Industry as a Source of Disease

The Atmospheric Content of Lead

Compensation for Occupational Diseases

The "Twenty-Five Up and Down" Exercise Test

Occupational Diseases and the Practice of Medicine

Book No. I

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Bibliography and Laws

All the References of the World's Literature
---from 1556 to December 31, 1933

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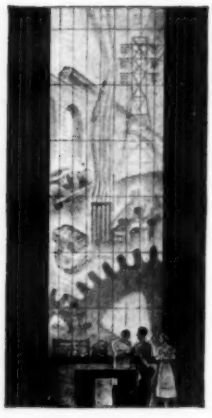

INDUSTRIAL MEDICINE
& RAILROAD SURGERY

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THE term "occupational diseases" has, of late, been much spoken. It is a mouth-filling term, and sounds impressive, and authoritative. But it has been used by many, very many, who have only a vague and general idea of what it means. This issue is remarkably enlightening in that respect; only a few can read DR. HAYHURST'S article, and DR. LEGGE'S, without a rearrangement, and a straightening-out, of preconceived notions, and a general re-ordering of meanings and connotations. The term has several excellent definitions, but these two articles, especially, are persuasive to both analysis and synthesis in respect of the group of words that will best express its significance. The articles will be found particularly valuable in the several localities where the phraseology of proposed statutes to cover occupational disease liability is still in process of formulation. Both authors have the medical knowledge and the industrial perspective—as to which the M.D. who is as yet inexperienced in the "occupational" relation can testify that they are two different things . . . WE like DR. HAYHURST'S implied definition of "industry" (p. 329) much better than DR. JAMIESON'S (p. 378). Industry is more than "manufacture." It is *all* occupation; everyone who is gainfully employed is in industry; "occupational" and "industrial" are synonymous . . . OUR editorial (p. 386) is a broad-line sketch of medicine's fine conservatism in this "era" of radical iconoclasm. Possibly, in spite of a considerable flair for mathematics and a profound respect for logic, we are yet unable to understand the statistics of the proponents of the so-called "social," or "state," medicine. For example, the figure quoted in the Florida report read by DR. VINSON (p. 396): "50% of the individuals (in the United States) were not financially able to obtain adequate medical and surgical care." We are moved to ask—not of DR. VINSON'S committee, however, but of the source and the propagandists of this kind of statement—"what of it?" At what time in our history did 50% of

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our population need medical and surgical care? There is authority for the figure of less than 5% as needing either or both at any one time—not 5% of the 50%, but 5% of the total of individuals who make up the census. Safely enough, therefore, the proportion of the low income people who need medical and surgical care is not more than 2½%. There ought to be propaganda in respect of the truth. But truth, somehow, seems expected to get along on its own. If, however, there were as much interest in educating the uninformed as to facts, as there is in deceiving them with untruths or half-truths, it would be generally known that anyone and everyone who *needs* medical or surgical care can get it by asking the medical profession for it—even though, as DR. GREENE remarks (p. 368) "the medical profession is paid for only about one-tenth of the service it renders the indigent." Organized medicine has no need to get into politics. But there is the possibility that it could very advantageously use a "liaison officer," as it were, in connection with its educational endeavors. Truth must prevail—but its ubiquity, to confound the propaganda of its perversion, could thus be better assured . . . OUR comments on the two articles herein mentioned are not intended to distinguish them above the others in these pages. Every article, of the 15 here included, is timely, interesting, and important. This issue finishes up the Midwest Occupational Disease Conference papers, with the exception of "Bronchogenic Carcinoma" by DR. PEIRCE, which will appear next month. We are, ourselves, impressed with the fact that our issues of last month and this month taken together afford the means of a fair education in "industrial medicine." Nowhere, at any time, has there been between the covers of any magazine, a better, more diversified, and more authoritative presentation of things pertinent to our field than will be found between page 229 (which began the May issue) and page 400 (which ends the June issue) of INDUSTRIAL MEDICINE . . . AND we welcome a new advertiser—LEVER BROTHERS, on page 387. They join the *select* group—for by no means every one who would sell to the *industrial* medical department can buy space in these pages. We have said "No" to an unbelievable volume of ads in the last two years. That is one of our contributions to the *quality* of our field, our readers, and our own responsibility as publishers of a *medical* magazine.

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Industrial Medicine

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The editors will exercise care in checking on the accuracy of data printed, but in all other respects articles and opinions of which expression is allowed are the opinions of their authors—the editors reserving in all cases the right to comment on the same, in the current or any subsequent issues, as they may be inclined.

The Journal of Occupational Diseases and Traumatic Surgery

The Science, the Law and the Economics of Industrial Health

Volume 6 JUNE, 1937 Number 6

Industry as a Source of Disease

—The Character of the Various Industrial Hazards, and Their Relative Importance—

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INDUSTRY means a place of business; also, being busy.* That industry should be a source of disease, either in regard to place of business or the nature of one's application, is truly an anomaly or an artifact and not something in the natural course of events, as I shall attempt to point out below.

The source of disease in industry is covered by the term "industrial health hazard". The word *disease*, itself, I am going to use in rather a broad sense to include not only pathological states but also disturbed functions and non-conformities in anatomical and functional status. Outside of this there is an industrial or occupational disease rate for certain common afflictions which statisticians show is in excess of the standardized rate for all gainful workers combined.[1] Space forbids my discussing this here except for an occasional brief reference.

Health is a good old Anglo-Saxon word meaning, "Hale, sound, and whole in body, mind, and soul". Hence, it is the state of well-being, or the quality of life. The threshold of well-being varies rather remarkably between individuals and in the same individual from time to time. Life is a broad highway. A marker down the center and a soft shoulder with a ditch alongside are the lateral limits for safe going. Drivers swerve from shoulder to center and even beyond these limits much too often, and this is when mishaps if not disasters occur. Usually, however, they swerve back successfully. This variation in thresholds Cannon[2] calls "homeostasis." Freely translated this means the ability of man to "stay put", despite thresholds of anatomical and physiological limits varying from the average or swervings from side to side. In short, the so-called threshold limit for a given hazard is no more fixed than biology itself, and the great field of study for the future is why some are more susceptible and others more tolerant. Why, in the most striking disasters, do 70 to 80% of those exposed, nevertheless, escape? In fact, only the more susceptible ever suffer from occupational diseases. Precision methods are of course preferable but it must not be forgotten that they have only a relative value due to "homeostasis" in the individual.

Our subject, *industrial health*, is but a phase of the general topic, "Hygiology." Usually it is classed as an environmental phase whereas health also covers *personal hygiene*, the *physical status quo*, and even *eugenics*, or the source of being.

Historical Background

TEXTBOOKS on occupational disease, dangerous trades, vocational hygiene, and industrial health cover this subject. The recent series of articles in INDUSTRIAL MEDICINE by Robert T. Legge[3] have encompassed the subject in both a broad and a particular way from the earliest Biblical times to the present. For America[4], in 1902, C. F. L. Doehring, a student of George M. Kober's at Washington, made the first official survey of industrial hygiene. This was done under the Hon. Carroll D. Wright, Commissioner of the Department of Labor, and the survey was made in the government shops in Washington. In 1905, Massachusetts was investigating its factories under Dr. William C. Hanson. In February, 1908, Dr. George M. Kober, while Secretary of Theodore Roosevelt's Homes Commission, published a volume upon the subject, INDUSTRIAL AND PERSONAL HYGIENE. In the same year valuable articles by Dr. George M. Price, Dr. C. T. Graham-Rogers, Dr. Frederick L. Hoffman, and Dr. W. Gilman Thompson began to appear.

In 1910, the Illinois Commission on Occupational Diseases finished its survey under the direction of Dr. Alice Hamilton and the guidance of Prof. Charles R. Henderson, Dr. Ludvig Hektoen, and others, and in June of the same year the First National Conference on Industrial Diseases met in Chicago at the call of the American Association for Labor Legislation under the guidance of Dr. John B. Andrews, Prof. E. R. Commons, Prof. Henry W. Farnam, and Dr. Henry B. Favill. Also, in New York City in 1910, Dr. Thompson started the first clinic on occupational diseases. This was followed in 1911 by the establishment of another at Rush Medical College, Chicago, by the writer, who had been with the Illinois Commission above mentioned.

Following these activities came those of the U. S. Bureau of Labor Statistics, the U. S. Bureau of Mines, the New York State Factory Investiga-

* Presented at the Midwest Conference on Occupational Diseases, Detroit, Michigan, May 3, 1937.

tion Commission (under Price in 1912-1914) and others; also, the impetus given by the XV International Congress on Hygiene and Demography held at Washington in 1912. For a summary of more recent events, one should consult the special report of the Harvard Tercentenary Celebration on Environment and Man.[5]

The Industrial Health Hazards

AN INDUSTRIAL HEALTH HAZARD is any condition or manner of work which is beyond the threshold of physiological adjustment of the human being so engaged.[6] It is to be noted that this physiology is adaptable by gradual tolerance to wide variations in environment and experiences, but subjection to conditions which are unnatural or beyond the threshold of physiological adjustment, including adaptability, results in pathology or disease (industrial or occupational disease).

These industrial hazards group themselves under 10 convenient headings:

1. The *poisons*—local, systemic, and constitutional.

2. *Mechanical irritants,* such as mineral or metallic dusts, producing dermatitis (often secondarily infected), or, when inhaled (and especially if there is an irritative solution in the pulmonary lymphatic), pneumoconiosis of various forms.

3. *Friction and pressure,* producing blisters, caloused places, worn teeth, bursitis, etc.

4. *Fatigue,* producing "nervous breakdown" or, when localized, synovitis, myositis, and other forms of strain, subluxations, avulsion, etc.

5. *Infections,* of which there are not many peculiar to industry itself but examples are, anthrax, glanders, tetanus, actinomycosis, and the very common "machinist's boils" associated with oils, greases, and cutting compounds—also, even such infections as typhoid fever, undulant fever, and tularemia where such occur from exposure on the job.

6. *Diseases following accidental injury* at work, such as secondary infections, deformities, and fibroses.

7. *Abnormal spectral conditions,* from the infra-red through the brilliant, or overly subdued "light" waves to and through the ultra-violet to x-rays and radium radiations, producing afflictions all the way from scorching, blistering, conjunctivitis, retinitis, ophthalmia, and nystagmus to bronzing, light burns, and epithelioma.

8. *Temperature extremes,* producing, on the one hand, thermic fever, heat retention, cramps, stroke, and collapse, and on the other, chilling followed by pneumonia, Bright's disease, etc., also local afflictions like frost-bite.

9. *Noise,* especially reverberating noises, which in time produce so-called "boiler-maker's deafness", and;

10. *Abnormal atmospheric pressures,* producing, on the one hand, compressed air illness of several types, including local effects such as ruptured eardrums, and, on the other, "rarefaction disease", as in aviation, mountain climbing, and, we might include here, asphyxial states due to decreased percentages of oxygen in the air so that mechanical and chemical factors combine. While custom has classified these abnormal atmospheric pressures and asphyxial states as "diseases" they usually partake more of the nature of acute or accidental mishaps.

TO summarize, a rapid method for spotting all usual health hazards in any industrial exposure, is to memorize 12 words or terms and apply them in the survey: Dust, Dirt, Dampness, Darkness, Devitalizing Air Conditions, Temperature, Fatigue, Infections, Poisons, Compressed Air, Stimulantism, and Susceptibility.

In some cases these terms also conjure up their opposites. This opinionative method was used, I believe, with entire success in the Ohio Survey of Industrial Health Hazards and Occupational Diseases,[7] 1913-1915, where a large number of industries had to be covered rapidly and with a small budget. McCord has competently discussed industrial hazards in his book "Industrial Hygiene for Engineers and Managers"[8], and more recently in his paper on the "Industrial Hygiene Survey."[9]

The Occupational Diseases

IT IS with the greatest difficulty that "hoc procter hoc" reasoning can be kept out of the present discussion. That is, we are so very apt to look at the mishaps and wreckage along the highway, in the nature of morbidity and mortality statistics, and assume forthwith that they are results of hazards upon the highway, when, too often, as we well know, the hazards lie with the drivers and very often were there before they left home for the trip. Nevertheless, I feel at least obligated to classify some of the obvious results of these exposures to industrial health hazards which are known as "occupational diseases".

When the condition of "homeostasis" is passed, that is, the threshold of natural adjustment is overstepped, any of these mentioned hazards may produce functional disturbances, actual impairment, or death.

Thus, an *occupational disease* is any affliction which is the result of exposure to an industrial health hazard.[10]

A ready classification of occupational diseases, which correlates them with industrial health hazards, is the following four groupings:[11]

1. The so-called *specific* or characteristic occupational disease; such as lead poisoning, silicosis, prepatellar bursitis, tenosynovitis, "machinist's boils", tar cancer, etc. In short, one or more quite characteristic occupational diseases can be named for each of the 10 hazards above enumerated.

2. *Diseases partly occupational.* These are afflictions where the hazards may exist elsewhere than in connection with the work, such as hereditary or congenital predisposition, pathological states, or faulty personal hygiene, bad living conditions, etc. For example, allergic asthma and dermatitis, tuberculosis, etc., can, at most, be no more than partly occupational in nature. Many diseases of the human body are occupational only to the extent that work may aggravate or re-activate the condition present. For example, the effects of heat cramp upon a duodenal ulcer, chronic pyorrhea as a sequella to benzol or lead poisoning, etc. Still the elimination of common, well-known health hazards would mitigate if not forestall the onward march of such afflictions.

3. *Occupational health complaints.* These are pre-disease conditions, such as headache, sleeplessness, dyspepsia, pain, numbness, stiffness, cough, etc. Being only symptoms and in themselves not true diseases, they are, nevertheless, the earmarks which should guide the industrial physician, engineer, chemist, and all health guardians

to the elimination of possible industrial health hazards.

4. *Conditions* which are neither diseases nor complaints, but which may be advanced by one's occupation: Examples are, postural defects, such as flat feet and round shoulders, or faulty work habits, such as constant nodding of the head in rhythm with motions of the hands, etc.

Some Statistical Evidences

ACCORDING to the U. S. Census for 1930, there were, of gainfully occupied workers in the United States, 48,829,920, of whom 38,077,804 were males and 10,752,116 were females.[12] While a great depression slump has taken place in the intervening years, possibly amounting to 10 million who were thrown out of employment, I have seen some recent figures which place the present total employment at approximately 45 million.

TABLE I

SUMMARY OF COMPENSABLE OCCUPATIONAL DISEASES REPORTED 1928-1936, INCLUSIVE
OHIO DEPARTMENT OF HEALTH, BUREAU OF OCCUPATIONAL DISEASES

No.	Name of Affliction	1928	1929	1930	1931	1932	1933	1934	1935	1936	Total
1.	Anthrax	—	—	—	—	—	—	—	—	—	—
2.	Glanders	—	—	—	—	—	—	—	—	—	—
3.	Lead poisoning	180	183	134	114	148	134	162	102	112	1269
4.	Mercury poisoning	—	—	—	—	—	—	—	—	—	—
5.	Phosphorus poisoning	—	—	—	—	—	1	—	—	—	1
6.	Arsenic poisoning	—	2	1	2	3	1	3	3	—	15
7.	Benzol poisoning (and nitro- or amido-derivatives)	11	11	3	6	9	3	10	7	3	63
8.	Volatile petroleum products poisoning (gasoline, benzine, naptha, etc.)	3	4	2	6	5	9	10	7	5	51
9.	Carbon bisulphide poisoning	1	1	—	18	2	1	1	—	6	30
10.	Wood alcohol poisoning	1	—	—	1	—	—	—	1	—	3
11.	Dermatitis (infection or inflammation of the skin on contact surfaces due to oils, cutting compounds or lubricants, dusts, liquids, fumes, gases or vapors)	894	985	884	833	621	726	913	875	930	7660
12.	Epithelioma (skin or eyes) due to carbon, pitch, tar or tarry compounds	3	2	1	5	1	1	—	—	—	13
13.	Compressed air illness	16	62	59	5	20	3	2	1	2	170
14.	Carbon dioxide poisoning	—	—	—	—	—	1	1	1	—	3
15.	Brass or zinc poisoning	7	5	2	10	2	12	8	3	—	49
16.	Manganese dioxide poisoning (1)	—	—	—	—	—	—	—	—	—	—
17.	Radium poisoning (1)	—	—	—	—	—	—	—	—	—	—
18.	(a) Tenosynovitis (hand) (1)	—*	37	130	166	149	191	228	218	178	1297
	(b) Prepatellar bursitis (1)	—*	13	23	29	23	19	27	25	27	186
19.	Chrome ulceration (nasal and skin) (2)	6	10	20	16	79	20	43	49	79	322
20.	Potassium cyanide poisoning (2)	3	2	—	1	3	5	—	1	2	17
21.	Sulphur dioxide poisoning (2)	2	—	—	5	4	2	7	1	2	23
	Total	1127	1317	1259	1217	1069	1129	1415	1294	1346	11172

* Statistics not kept on Tenosynovitis and Bursitis in 1928. Both of these afflictions had been compensated as "accidental' injuries previous to July 1, 1929.

(1) Added to compensable list July 31, 1929, by Legislative Act, 89th General Assembly.

(2) Added to compensable list July 9, 1931, by Legislative Act, 90th General Assembly.

A decade or two ago mid-life was the safest age, while death rates were high for the child and youth as well as for the aged. However, things have shifted remarkably, and the safest age is now in the period of youth and the safest year that of age 11.[13] Even here, accidents cause 36.8% of the deaths of boys and 11.4% of the deaths of girls. The Census covers gainful workers from 10 years of age onward.

Man's recent and rapid control of the communicable diseases in civilized countries is no doubt the chief cause of this shift. This control is no better illustrated than in the situation created by the great Ohio River flood of January and early February this year when possibly 1,500,000 persons were dislodged from their homes and often assembled in large numbers in many places, but with no increase whatever in communicable diseases of any nature.[14] This is the more remarkable when we consider that this was in the midst of the winter season when the respiratory diseases are at their zenith, and it contrasts especially with the war period of 1917-19, when the respiratory diseases ran rampant. The situation is not so favorable, however, in working groups as will be shown below.

In the *British Journal of State Medicine*, for October, 1936, Dr. A. Massey,[15] commenting on health and safety in the factory, found that time lost through sickness was much greater among works employees than among office staffs. For example, FIRM A had respective percentage losses per week as follows: Works employees 2.82, office staff 0.82; FIRM B, 3 vs. 0.4; and FIRM C, 2.25 vs. 1.5. These were large engineering firms in Coventry, employing from 2066 to 2391 in the works and 368 to 500 in the office. The author, in searching for an explanation, observed that office workers were often drawn from more educated groups than manual workers and accordingly were better versed in the practice of personal hygiene. They also enjoyed in the main better home environment. Again, initial selection as to suitability for their jobs was more systematic in the case of the office staff, and they had more permanent terms of employment. Furthermore, the larger number of works employees increased the chances of both importation and spread of infections while the hazards appertaining strictly to

occupation were, of course, greater among works employees.

Ohio Occupational Disease Statistics

THE PERIOD 1913-1936: According to the official statistics compiled in Ohio over the period from May 15, 1913, to the end of 1936, a total of 20,296 occupational diseases was reported.[16] Of these 2,575 occurred in the eight years prior to the time compensation for occupational diseases began (August 4, 1921), or an average of 322 cases a year; since compensation began (15.4 years), 17,624 cases were reported, or a yearly average of 1,144 cases. Acute mishaps, even though due to poisons, corrosives, asphyxiants, etc., and incomplete reports are not included in any of these figures. In Ohio, occupational diseases are divided, for convenience, into the compensable group and the non-compensable group.

There are 21 causative agents listed in the schedule of compensable diseases. These are shown in the accompanying Table I. The first 15 of these were scheduled for compensation August 4, 1921, the next three, July 31, 1929, and the last three, July 9, 1931.

THE PERIOD 1928-1936 ANALYZED: A glance at TABLE I, which covers the 9-year period from 1928 to 1936 inclusive, shows a total of 11,172 *compensable* cases[17] reported and that 7,660, or 68.6%, of these were due to dermatitis caused by "infection or inflammation of the skin on contact surfaces to oils, cutting compounds or lubricants, dusts, liquids, fumes, gases or vapors". Broad as this coverage appears, it, nevertheless, omits industrial skin afflictions due to physical agents, viz., friction, heat, cold, light, and radiant energy of any form. It also omits perspiration-irritation.

The second leading cause comes under strain or fatigue, viz., 1,297 cases, or 11.6%, of tenosynovitis, involving the flexor or extensor muscles of the hand (only), and 186 cases, or 1.7%, of prepatellar bursitis, both of which afflictions were added to the schedule in 1929.

The third group of significance is lead poisoning with 1,269 cases in the nine year period, or 11.4% of the entire group.

The fourth group is chrome ulceration involving either the nose or the skin with 322, or 2.9% of the cases. Chrome skin ulcers, it will be observed, are scheduled separately from dermatitis in Ohio.

The fifth group is compressed air illness with 170, or 1.5% of the total cases, and occurring practically altogether in the first five of the nine years.

Thereafter follows benzol poisoning, including its nitro- or amido-derivatives, with a total of 63, or 0.6% of the cases, or exactly seven per year. This is followed by volatile petroleum products with a total of 51, or 0.5%.

The less significant causes of compensable occupational diseases were, in descending order: Poisoning by brass or zinc (49), carbon bisulphide (30), sulphur dioxide (23), potassium cyanide (17), and arsenic (15); then follows tar cancer (13), and finally three charged to poisoning by carbon dioxide, three to wood alcohol, and one to phosphorus.

It is notable that during this nine-year period there were no cases reported of anthrax, glanders, or poisoning by mercury, maganese dioxide, or radium. An analysis of the reported *non-compensable* cases is given below.

The Industry as a Hazard

I HAVE been greatly assisted by Dr. W. E. Masters, former Chief Medical Supervisor, and Dr. K. D. Smith, now Chief Medical Supervisor, of the Bureau of Occupational Diseases of the State Health Department, in compiling the following data for Ohio for the year, 1936.

The industries in which occupational diseases occurred are represented by the 1,453 cases reported for that year.[18] We can give but the bare figures and not the rates since the number employed in each industry is not known, nor can it be closely estimated. You all know that Ohio is a state with extensive manufacturing, transportation, trade, mining and agriculture, also with extensive institutions and utilites. Steel, automoble, food, electrical goods, rubber, clothing, publishing, are all paramount industries. (See TABLE II) It has not been possible to observe a standard terminology in our use of the terms "industry" and "occupation" because we have had to rely upon the reports of physicians, very few of whom have any knowledge of a standardized terminology in this field and especially that recommended by the U. S. Bureau of Census.[19]

OCCUPATIONS OR TRADE PROCESSES AS A HAZARD: The Ohio occupational disease reports for the year 1936 were listed as shown in TABLE III, for occupations or trade processes.

AGENTS PRODUCING OCCUPATIONAL DISEASES: An Ohio law of 1913 (Section 1243-1 to 5, G.C., Ohio) makes all occupational diseases reportable (by the attending physicians) to the State Director of Health. The agents producing them are best classified by noting the types of diseases produced. Sexes, also the number of reporting physicians and employers, can be stated. Of the 1,453 cases reported in 1936, 249, or 16.3% were females; 1,248, or 83.7% were males. The percentage of females the preceding year was 20.3%, and in 1934 it was 18.6%.

This total of 1,453 cases was reported by 64 physicians, or approximately 7.3% of the 9,000 practicing physicians in Ohio. They were employed by approximately 833 different employers.

1. *The compensable cases* (Section 1465-68a, G. C., Ohio) are delineated in Table I. There were 1,346 cases in this group (92.6% of the total); 1,112 (82.6%) were males and 234 (17.4%) were females. For the nine-year period ending with 1936, the total compensable cases numbered 11,172. (See Table I).

In 1936, *dermatitis*, with 930 cases, constituted 64% of the total reported cases, and 68.4% of the compensable cases.

The *chief causes of dermatitis were*: Oils, greases and cutting compounds, 211; specified chemicals, 97; chemicals, not specified, 78; cleaning compounds, 65; plating and cyanide solutions, 59; paints, lacquers, enamels, varnishes, thinners and turpentine, 59; plants, flowers, vines, vegetables, grains and fruits, 52; petroleum and its products 48; stains, dyes and dyed goods, 44; bakelite and other synthetic resins, 37; inks, blue prints, etc., 25; dusts, variously specified, 23; rubber, 21; lime and cement, 19; bakery and confectionary goods, 18; wool, fur, glue, hair, feathers, 17; irritants, not otherwise specified, 15; brass and zinc, 15; adhesive cement, 6; abrasives (polishing rouge), 6; leather, hides and shoes, 5; infestations, 4; fish and meats, 4; paste (not otherwise speci-

fied), and garbage and rubbish, only one each.

Lead poisoning comprised 112 cases, 10 more than in 1935. The occupations of the workers were as follows: Painters (general painting, 14; spray painting, 12; others 4), 30, compared with 15 in 1935 and 26 in 1934; foundrymen (moulders, etc., of non-ferrous metals), 23; storage battery workers, 18; enamelers of sanitary ware, 12; white lead workers (manufacturing white lead), 8; printers, electrotypers, lithographers, etc., 5; automobile manufacturing and repairing, 5; manufacturing steel and its products, 4; glass workers, 3; clay products workers, 2; window puttier and junk worker, 1 each. *Three women* incurred lead poisoning, two in decorating glassware, one employed making bolts and nuts. In the eight years (1928-1935, inclusive), 71 deaths were associated with lead poisoning, 10 occurring in 1935 (figures for 1936 not yet available).

There were also reported 79 cases of *chrome ulcers*, 24 occurring in women. The nasal mucosa was affected in 44 and the skin in 35.

Other compensable poisonings totaled 18; carbon bisulfied, 1, and its derivatives (carbon tetrachloride, 4; butyl acetate, 1) (two females), 5; petroleum products, 5; benzol, 3; potassium cyanide, 2; sulfur dioxide 2.

Tenosynovitis of the hand (wrist) registered 178 cases, of which 57 were females; *prepatellar bursitis* or "housemaid's knee", 27 cases, only two occurring in females.

Compressed air illness ("caisson disease") accounted for two cases in sewer construction work.

The following compensable diseases reported *no cases*: Anthrax, glanders, epithelioma or skin cancer, and poisoning by mercury, phosphorus, arsenic, wood alcohol, carbon dioxide, brass and zinc, manganese dioxide, radium.

2. The 107 *non-compensable* occupational diseases reported, including 15 females (6 with constitutional symptoms), are of considerable interest. Dusts were responsible for 40; variously specified fumes and chemicals, 25; tenosynovitis (other than wrist) from repetitive motion, 8: infections, 10 (undulant fever, 2; tularemia, 4; tuberculosis, 3; Vincent's type organisms, 1); pressure, 3; lifting, 2; acids, 2; chrome (constitutional), 2; cyanide poisoning (other than the compensable potassium cyanide), 2; heat (thermal dermatitis), 2; chronic carbon monoxide poisoning, 2; the rest, scattered causes.

Analysis of the 40 *dust cases* reveals pneumoconiosis in some form was the cause in 30 cases (only a few checked by the Department*); Silicosis, 14; silicosis with siderosis, 4; silicosis with tuberculosis, 1; silicatosis, 1; pneumoconiosis, not otherwise specified, six. In the remaining 10 cases, inorganic and organic dusts caused upper respiratory and conjunctival irritation. The dusts causing the pneumoconioses arose chiefly in foundries, mines, sandblasting and clay industries. At the end of the year, an inquiry was made of the 21 tuberculosis institutions in the State. Of these, six reported upon pneumoconiosis in general. They specified 11 cases of silicosis exclusive of those enumerated above, and one sanatorium reported 35 additional pneumoconiosis cases, exclusive of silicosis. Among the tuberculosis institutons, Hamilton County (Cincinnati), the largest (635 beds), also Franklin County (Columbus) (210 beds), reported no case of any form of pneumoconiosis.

Undulant fever showed two cases and *tularemia* four cases, considered as industrial in origin. There was one case of each in 1935.

During the nine-year period, 822 non-compensable cases were reported, of which 596 were

TABLE II.

INDUSTRIES ASSOCIATED WITH OCCUPATIONAL DISEASES IN OHIO, YEAR 1936

Number of Cases Reported in Each

Industry	Total	Male	Female
1. Iron and steel products (mfg.)	176	162	14
2. Foods and confectioneries (mfg. and handling)	131	102	29
3. Electrical products (mfg.)			
Electroplating	66	64	2
Storage batteries	23	23	0
Appliances	41	35	6
4. Automobile and parts (mfg.)	124	108	16
5. Tools, metal stampings, machine products (mfg.)	95	70	25
6. Rubber products (mfg.)	82	65	17
7. Institutions (public and semi-public	60	49	11
8. Machinery (mfg.) (n.o.s)	49	45	4
9. Construction (buildings, roads, etc.)	48	48	0
10. Cloth, clothing, dyed goods (mfg.)	44	30	14
11. Printing and publishing	40	35	5
12. Synthetic resins (mfg.)	37	30	7
13. Glass (mfg.)	36	33	3
14. Foundry products (non-ferrous) (mfg.)	31	30	1
15. Wood products (mfg.)	30	24	6
16. Unclassifiable	29	24	5
17. Retail merchandising	27	11	16
18. Chemicals (mfg.) (n.o.s.)	27	25	2
19. Window shades (mfg.)	21	0	21
20. Leather, shoes, and leather goods (mfg.)	21	15	6
21. Sanitary ware (bath tubs, sinks, etc.) (mfg.)	21	18	3
22. Paints, lacquers, varnishes, etc. (mfg.)	20	20	0
23. Clay products (mfg.)	17	14	3
24. Alcoholic beverages (mfg.)	16	12	4
25. Public Utilities			
Gas and Electrical	8	8	0
Common carriers, railways, buses, etc.	8	8	0
26. Stoves (mfg.)	15	15	0
27. Farming, horticulture, gardening, etc.	14	12	2
28. Laundry and dry cleaning	14	10	4
29. Roofing and roofing materials (mfg.)	12	12	0
30. Auto sales and service	11	11	0
31. Paper and products (mfg.)	10	5	5
32. Beauticians	8	2	6
33. Bicycles	7	6	1
34. Caskets and vaults (mfg.)	7	7	0
35. Plumbing supplies and plumbing (mfg.)	7	7	0
36. Coal mining and dealing	7	7	0
37. Mfg. of petroleum products and dealing	5	5	0
38. Dental supplies (mfg.)	4	1	3
39. Saw mill and planing products (mfg.)	4	4	0
40. Carbon, coke products (mfg.)	4	3	1
41. Musical instruments (mfg.)	3	3	0
42. Banking	3	2	1
43. Vegetable oils (mfg.)	3	3	0
44. Cigars, tobacco (mfg.)	3	0	3
45. Matches (mfg.)	3	1	2
46. Raincoats (mfg.)	2	1	1
47. Grass mats (mfg.)	2	0	2
48. Soap (mfg.)	2	2	0
49. Junk dealing	2	1	1
50. Warehousing	2	2	0

One case was reported in each of 20 other industries.

* In the diagnosis of silicosis and other pneumoconioses, this Department has followed the recommendations of the Committee on Pneumoconiosis of the American Public Health Association as rendered in the *Year Books*, 1931-32 (p. 131), 1932-33 (p. 100), and 1935-36 (p. 65).

"agent" cases and 226 were "afflictions" (agent not specified). Of the 822, approximately 274 were due to inhaling dusts, 11 were asthma, 70 were tuberculosis (alleged industrial) and the balance scattered.

Summarizing the 1,453 cases reported in 1936, 969 occurred by way of the skin, 251 chiefly by inhaling substances, 188 through strain, 30 by pressure or friction, and 15 by other means.

Acute mishaps (31) even though due to poisons, corrosives, asphyxiants, etc., *non-occupational diseases* (7); and *incomplete reports* (9) are not included in any of these figures.

In 1936, one plant physician reported 79 cases, 4 industrial physicians reported between 31 and 40 cases each, and three reported between 21 and 30 cases each. It can readily be seen that private physicians reporting but one or two cases made up the vast majority.

PNEUMOCONIOSIS REPORTS ANALYZED BY INDUSTRY: In Ohio, 284 cases of pneumoconiosis were officially reported in the 10-year period, 1927-1936. In 1931, Dr. Byron E. Neiswander [20] of the Ohio Health Department analyzed 59 cases of pneumoconiosis from 26 localities, giving the industries and occupations involved. These cases occurred between 1927 and 1930, inclusive. To these I have added 54 more Ohio cases occurring between 1931 and 1936, inclusive. TABLE IV shows the sources of these 113 cases by industries, and TABLE V, by occupations. The manufacture of iron and steel, and of pottery and refractories' products lead the industries, while sandblasters and pottery workers lead the occupations. The numbers, of course, are small, and merely suggestive of the chief sources of pneumonoconiosis.

SILICOSIS: In 1926 Kindel and Hayhurst[21] made a study covering job, race, exposure, symptoms, and stereoscopic x-ray examinations of 912 sandstone workers in a 50-year old industry at South Amherst, Ohio. This was accompanied by a chemical, minerologic, petrographic, and comparative tuberculosis study.[22] Of these 912 men, pulmonary pathology was found 55.1%, including 28.5% with silicosis in various stages. The total tuberculosis, however, was but 1.9%. Likewise, general disability was low. The tuberculosis findings checked relatively closely with the tuberculosis statistics of the commuinty. A check-up in 1932 of the county tuberculosis records revealed that only five deaths had occurred from tuberculosis among those workers, still resident, in the intervening six years, and but five active cases were on record.[23] In the next five years only some 12 to 15 additional cases of tuberculosis have been reported among these workers. Silicosis with low incidence of tuberculosis is reported in case reports in both of the last triennial summaries from South Africa (2 out of 20,000 men, etc.) and relatively low in post-mortem findings 20-30%, etc.)[24] The same is true in reports from other parts of the world. Theoretically the two diseases should be antagonistic, but the mass of older evidence, in particular, is all to the contrary. Evidently the matter needs more investigation. The average period for developing silicosis was 16.24 years, in our sandstone inquiry. The rock had an average content of 92.15 to 97% crystalline silica ($Si O_2$). Of the total number, 409 were essentially negative, 238 had increased fibrosis, 180 beginning silicosis, 45 moderate silicosis, 22 far advanced silicosis, 13 silicosis with tuberculosis, and five were tuberculosis alone.

While the men in our study ranged from 17 to 73 years of age, few under 25 had silicosis, but at 34 years of age and after 44 years of age, there were usually as many and sometimes more silicotics than non-silicotics at each year of life. Years

TABLE III.

OCCUPATIONS OR TRADE PROCESSES ASSOCIATED WITH OCCUPATIONAL DISEASES IN OHIO

Year 1936—Number of Cases Reported in Each

Occupation	Total	Male	Female
1. Machinists, machine operators, mechanics	291	265	26
2. Electroplaters	145	116	29
3. Painters, enamelers	127	117	10
4. Food handlers, bakers, and confectioners	92	64	28
5. Rubber workers	76	60	16
6. Cleaners, janitors, etc.	65	47	18
7. Iron and steel workers (n.o.s.)	64	63	1
8. Laborers (n.o.s.)	62	62	0
9. Dyers, handlers of dyed cloth and clothing	36	22	14
10. Glass workers	36	31	5
11. Synthetic resins (bakelite, etc.)	34	27	7
12. Printers, book binders, publishers, lithographers, electro-typers	30	26	4
13. Foundry men (non-ferrous)	25	25	0
14. Chemists and chemical workers	23	20	3
15. Foundry and machine shop workers	22	19	3
16. Storage battery workers	21	21	0
17. Clerks, retail merchandising	21	8	13
18. Window shade workers	20	0	20
19. Grinders, sanders, and treaters (iron and steel)	19	18	1
20. Photographers and blue-printers	19	19	0
21. Leather and shoe workers	19	12	7
22. Carpenters and wood workers	19	17	2
23. Construction workers (buildings, roads, etc.)	18	18	0
24. Laundry and dry cleaning workers	18	13	5
25. Paper workers	15	5	10
26. Clay products workers	13	13	0
27. Electricians, workers in mfg. electrical equipment	13	11	2
28. Farmers, florists, orchardists, gardeners, etc.	11	9	2
29. Chromate workers (mfg.)	10	10	0
30. White lead workers	9	9	0
31. Beauty parlor operators	9	2	7
32. Miners (coal)	8	8	0
33. Polishers and buffers	7	7	0
34. Institutions (public and semi-public)	7	6	1
35. Oilers, oil, and petrol workers	6	6	0
36. Sand-blasters	5	5	0
37. Professional persons (doctors, dentists, musicians, etc.)	5	3	2
38. Truck drivers	5	5	0
39. Unknown	5	4	1
40. Plumbers	5	5	0
41. Welders	5	5	0
42. Alcoholic beverage workers	5	4	1
43. Galvanizers and tinners	4	4	0
44. Auto workers (auto parts, repairs, service)	4	3	1
45. Firemen	4	4	0
46. Roofers	3	3	0
47. Mineral wool workers	3	3	0
48. Dental supply workers	3	1	2
49. Mill hands not otherwise specified	2	2	0
50. Grass mat workers	2	0	2
51. Refrigerator workers and service men (elect.)	2	2	0
52. Bank clerks	2	1	1
53. Glazers	2	2	0
54. Fertilizer worker	1	1	0
55. Window puttier	1	1	0
56. Solderer	1	1	0
57. Motorman	1	1	0

of exposure and certain jobs (grindstone and curbstone workers, saw setters, hookers, rockmen, etc.) were directly related to the incidence of silicosis, but race and work outside or within enclosures appeared to be of little significance.

Acute silicosis, or that occurring with a few weeks' to a year or two's exposure, was reported as early as 1713,[25] while an unusual outbreak was reported by W. W. Betts in Nevada in 1899,[26] involving hundreds of cases, and another at Gauley Bridge, West Virginia, in 1932-33.[27] Here a large amount of fine siliceous dust was involved, while dust-pneumonia and possibly acute tuberculosis occurred in many cases. The situation seems similar to the scourge to American soldiers while patrolling the Mexican border in 1915-16, and to the effects of dust storms in the Middle-West today. When it is recalled that there are three isotopes of silicon and some eight stabilities as regards temperature ranges in the natural formation of silica, the possible range in biologic effects of this

Table IV

Silicosis, Silicatosis, and Asbestosis by Industries in Ohio

1927-1936, Special Cases Investigated
Ohio Department of Health, Bureau of Occupational Diseases

Industry	Number
1. Iron and steel products (mfg.)	38
2. Pottery, refractories, (1 brick, 1 cement)	21
3. Monuments, granite, stone (n.o.s.)	10
4. Coal mining (1 dealer)	9
5. Brass, other soft metals (mfg.)	8
6. Sanitary Ware	7
7. Sandstone	6
8. Auto accessories (n.o.c.)	5
9. Storage battery containers	2
10. Asbestos	2
11. 1 chemicals, 1 furniture, 1 glass, 1 live stock, 1 matches	5
Total	113

complex element and compound becomes apparent.[28] The literature is annotated in the recent three volumes of Davis, Salmonsen, and Earlywine;[29] also by Harrington and Davenport of the U. S. Bureau of Mines.[30]

Changes in the Nature of Agent-Hazards

CERTAIN poisons, such as benzol, aniline, carbon bisulphide, and carbon monoxide, which were prominent 20 years ago, have largely disappeared as industrial hazards, no doubt chiefly because attention has been focused upon them, while others, especially new toxic agents, have taken their places.[31] We see, daily, the paradox of a new method engineered to the last detail for production or perfection, with no thought given to a preliminary investigation of possible health hazards, with the result that employees become human guinea pigs far too often in establishing the hazards which arise. Of this, there have been several outstanding examples, such as distilled turpentines and tetraethyl lead in their early manufacture, radium in watch dials, and the silica-using or producing industries.

Whether or not primary cancer of the lungs is increasing because of the inhalation of irritating substances is a very controversial question at the present time. A suspicion has been cast toward silica dust as well as to irritating factors in the inspired air. There seems no doubt, however, of the association so far as cobalt-arsenic ores are concerned in Schneeburg, Germany.[32] Arkin and Wagner[33] found 72% of 135 cases of primary cancer of the lung to have occurred in men between 41 and 60 years of age, and only 10 to have occurred in women. Dr. George M. Curtis[34] says that, "at the present time the incidence of cancer originating within the lung is considered approximately 10% of all malignancies of the body." He is inclined to favor extraneous irritating substances as significant, including tobacco smoke and industrial dusts and irritants.

Lack of Interest on the Part of Labor

IN AMERICA, a truly anomalous condition prevails in that organized labor itself leaves the health question pretty largely to the individual worker. It does little in the way of educational or investigative work in the matter of occupational diseases as may be seen by a scrutiny of its various publications.

Table V

Silicosis, Silicatosis, and Asbestosis by Occupations in Ohio

1927-1936, Special Cases Investigated
Ohio Department of Health, Bureau of Occupational Diseases

Occupation	Number
1. Sandblasters	31
2. Pottery and porcelain workers	18
3. Grinders and polishers	11
4. Molders, foundry men	11
5. Coal miners	8
6. Monument makers	6
7. Quarrymen (n.o.s.)	5
8. Stonecutters (n.o.s.)	5
9. Clay mixer men	3
10. Furnace builders, repairers	2
11. Fire pit workers	2
12. Asbestos workers	2
13. One each of: gas (mfg.), machinist, assembler auto parts, welder, glassworker, cement worker, hog sorter, furniture sander, chemicals mixer	9
Total	113

Accidents Versus Diseases in Ohio*

IN TABLE VI is shown the average number employed per annum, the number of accident claims (with fatalities), and the number of occupational disease claims (with fatalities) over the *10-year period, 1927-1936*. The estimated average annual number of employers or establishments (not shown in the Table) was 40,772 during this period with extremes ranging from a low of 37,578 in 1933 to a high of 45,203 (estimated) in 1936.

The average number employed per annum was 1,058,040, with extremes ranging from 817,862 in 1932 to 1,278,992 in 1929.

The average annual number of accidents was 187,268, of which 1,037 were fatal. Accidents ranged from 129,101 in 1933 (of which 883 were fatal) to 260,485 in 1929 (of which 1,258 were fatal).

The average annual number of occupational diseases was 1,258 (of which 27 were fatal), with

* I am indebted to Mr. Evan I. Evans (Actuary), Mr. C. C. Beasor (Statistician), and Mr. W. R. Scofield (Division of Labor Statistics) of the Industrial Commission of Ohio, and Professor Lester S. Kellogg, of the Department of Business Organization, Ohio State University, for the fundamental figures under this heading.

a range from 1,051 (including 22 fatalities) in 1927 to 1,445 (including 33 fatalities) in 1930.

Incidentally, in 1936, the average accident claim covered by the State Fund cost $66.14, and the average occupational disease, $114.35.

Of course, the very insignificant number of occupational diseases as compared to accidents is outstanding, and is clearly out of step with insurance data and employment sickness data as compiled by many observers. A partial explanation lies in the greatly restricted schedule set up by law in Ohio for compensating occupational disease claims, while, no doubt, the vast amount of sickness occurring among industrial employees, which was found by Sappington some years ago to amount to 20 times the number of cases of accidents and to cause seven times as much absenteeism, is very largely attributable to community factors and the mode of living.

TABLE VI

EMPLOYMENT AND DISABLEMENT, OHIO, 1927-36.

Year	Average Number Employed	Number of Accident Claims		Number of Occupational Disease Claims	
			Fatal		Fatal
1927.....	1,171,267	218,946	(953)	1051	(22)
1928.....	1,197,885	228,020	(1078)	1213	(30)
1929.....	1,278,992	260,485	(1258)	1416	(37)
1930.....	1,133,846	211,305	(1225)	1445	(33)
1931.....	963,791	170,528	(1094)	1240	(40)
1932.....	817,862	130,379	(954)	1140	(29)
1933.....	854,991	129,101	(883)	1215	(23)
1934.....	980,594	158,022	(935)	1226	(21)
1935.....	1,068,456	163,316	(942)	1256	(20)
1936.....	1,112,720(est.)	202,580	(1048)	1376	(18)
Total.....	10,580,404	1,872,682	(10370)	12,578	(273)
Average per Year.....	1,058,040	187,268	(1037)	1258	(27)

Industrial Mortality Statistics

IN 1892, Sir Thos. Arlidge, in one of his Milroy Lectures,[35] stated: "The vital statistics of occupations can only be general and approximative. Mortality returns of themselves are insufficient to show to what extent the deaths in an occupation are due to its pursuit. They represent the number following that occupation who have died, and so afford a crude idea of the relative frequency therein of certain fatal forms of disease."

Those who are interested in this phase of the subject would do well to consult the Registrar-General's Decennial Supplement for England and Wales (Part II, Occupational Mortality),[36] and the more recently compiled statistics of Dean K. Brundage,[37] Rollo H. Britten, [38] and William M. Gafafer[39] of the U. S. Public Health Service, and the reports of Louis I. Dublin and his associates.

Jessimine S. Whitney,[40] statistician of the National Tuberculosis Association, showed that when deaths from all causes were arranged according to social-economic class in 10 selected states, in 1930, the *standardized death rate* for all gainfully occupied males per thousand was 8.70. For agricultural workers, it was only 6.21, professional men 7.00, proprietors, managers, and officials 7.38, clerks and kindred workers 7.40, and skilled workers and foremen 8.12; but for semi-skilled workers, it was 9.86, and for unskilled workers 13.10. Between 1910 and 1930, *tuberculosis*, the great criterion disease of environmental health conditions, receded from first to seventh place as a cause of death in the general population, but still stood in second place in 1930 for gainfully occupied males.

Rollo H. Britten,[41] statistician for the U. S. Public Health Service, showed the major causes of excess mortality among unskilled workers as compared to all gainfully employed, taken as 100, was as follows: Tuberculosis 211, pneumonia 196, industrial accidents 175, cirrhosis of liver 159, nephritis 144, heart diseases 139, cerebral hemorrhage and softening 139, cancer 130.

In 1936, the Metropolitan Life Insurance Company[42] found that the chief cause of all deaths between 20 and 44 years of age was tuberculosis.

A study of Ohio vital statistics[43] showed that in *mechanical and manufacturing industries,* in 1929, the *tuberculosis* death rate for *females* was 118.1 versus 96.6 for males and that, in 1930, the tuberculosis death rate of female workers was nearly six times that of males.

Brundage[44] points out that clerks have a lower rate of mortality than the proprietors, managers, and officials who employ them. Both in England and the United States the death rate of ministers and preachers is almost as low as that of agricultural workers. Again, economic status is really a minor factor since, for example, the concept of affluence is not associated with the status of the average farmer who, of all persons, has the longest life. 'In Scotland, fishermen, shepherds, gardeners, and foresters are extraordinarily free from disease and especially when compared with the morbidity experience of coal-miners of Scotland.' 'It appears, also, that, in the United States, good health and long life are not dependent to any very important extent upon climate, but, from mortality data, upon conditions of life, such as celibacy, mode of living, and occupational exposures incident to our industrial civilization.'

The question is: Do agricultural, pastoral, and even clerical and mental pursuits provide biological necessities for health, longevity, and accomplishment? At least it appears that health and longevity are only indirectly, if at all, dependent upon affluence, station, education, or work, except where work involves an artificial mode of living or hazardous working conditions, or both.

In closing, I am much inclined to the idea that, in general, a low state of health of the industrial population is closely associated with prolonged states of industrial unrest, and that if it is hazardous to human lives to produce an article of human usefulness, then the cost of production must include the cost of health protection. Industry should not be a source of disease, but a source of health and happiness.

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The "Twenty-Five Up and Down" Exercise Test

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THE problem of a satisfactory and simple exercise test for routine use in physical examinations confronts every physician who deals with large groups of individuals. Many tests have been suggested and their very number indicates that general acceptability has not been found.

The majority of these procedures have been developed by cardiologists for use in private practice or in special clinics devoted to cardiovascular diseases. They are designed to yield a fairly accurate estimation of the circulatory efficiency of the subject being examined. Among the better known and more widely used tests are, stair climbing, the two-step test, hopping on one foot, and toe-touching calisthenics. While each of these has certain special advantages, and they all serve their particular purpose admirably, they are found to present some disadvantages when applied to the rapid examinations of large numbers of subjects.

For the special purpose of handling large groups in survey work, pre-employment examinations, or compensation ratings, the exercise test should conform to certain requirements which need not be met in consulting room work. In addition to the fundamental purpose of giving a fairly accurate estimate of circulatory and respiratory efficiency, the test should: (a) consume the minimum of time, (b) should be adapted to the routine of the examination with as little interruption and as little ceremony as possible, (c) should permit the blood pressure readings, and the pulse and respiration count to be taken immediately after the exercise, (d) should permit the examiner to carefully observe the subject throughout the test in order to note cyanosis, altered respiration and other abnormalities, (e) should be a type of exercise not customary to the subject in his work or daily activities, so that especially trained sets of muscles and their habitual coordination will not give false ideas of efficiency, (f) should enable the examiner to check objective findings against subjective claims even though the subject fails to cooperate

wholeheartedly, (g) should be broadly applicable.

The writer has used a simple procedure which he believes fills all these requirements, and which in his own work has proved more than passably satisfactory. It is offered here, not as the last word in perfect exercise tests, but in the hope that others may try it and in passing judgment on its usefulness, offer suggestions for improvement. For want of a better term, the writer calls it the "Twenty-Five Up and Down" Test.

This performance is simplicity itself. There comes a time in any complete physical examination when the subject lies supine on the examining table. The few minutes necessary to permit the subject to relax are occupied by some other details of the examination. The writer uses this brief time to outline the area of cardiac dullness and auscultate the heart. Then the pulse is counted and the first blood pressure reading taken, while another observer notes the respiratory rate. The subject is then instructed to grasp the sides of the examining table, to pull himself up to a sitting position and let himself down again. He continues this "Up-Down, Up-Down," until he has performed the act 25 times, or until in the opinion of the examiner he should not be allowed to proceed further because of disability.

During the exercise the examiner stands beside the table and closely watches the subject for objective signs of disability or over exertion. The sphygmomanometer cuff is left in place on the arm so that the next reading may be made instantly after the exercise is completed. For convenience, the writer uses a Tycos apparatus and holds the instrument head and bulb, still attached, in his hand, which he lets rise and fall with the movements, simultaneously observing the subject and counting the undulations. Immediately upon the final "down" the subject is again supine and the blood pressure is obtained, followed at once by the observations on the pulse. Both recordings can be accomplished in considerably less than a minute. In the meantime, the second observer has counted the respiratory rate. This seeming disadvantage of requiring the services of an extra person is more than compensated for by the fact that the subject's attention is diverted from his respiration by the business of taking his blood pressure; a point well worth considering if one is dealing with possible compensable disability in which malingering might be a factor. It is difficult for anyone to breathe naturally when aware that the respirations are under observation, no matter how well intentioned the person may be.

In routine examinations the final observations are made after an arbitrary time allowed for the return to normal—say two or three minutes—the intervening period being utilized for some other detail of the examination such as abdominal palpation, search for hernias, etc. If some abnormality of the cardiovascular system is suspected the examination of other parts of the body may be postponed and the behavior of the heart and pulse observed continuously until full recovery.

The advantages of this particular procedure do not require any great elaboration. As to the time required, two minutes or less will suffice on the average for the 25 "ups and downs." Even lethargic individuals will seldom take more than two minutes. Those who present physiological impairment will have stopped of their own accord, or will have been stopped by the examiner, before completing the standard of 25.

The test is well adapted to routine because the subject starts and stops in a routine position. He does not leave the examining table. At the close of the exercise he is automatically in position for immediate observation. During the exercise, he constantly faces the same quarter which permits continuous close observation.

The exercise itself is one which is unusual for the most persons, whether workmen or others. Some of the other tests lose a part of their significance when applied to workmen who habitually climb stairs, ladders or ramps in the course of their daily occupation. Perhaps the only groups of people who have developed this particular muscular coordination are oarsmen and those few who frequent gymnasiums. In many hundred examinations in which this test was used, the writer found only one individual who was accustomed to it. He stated that he "could do this all day"—that he took a work-out in a local gymnasium twice a week!

PERHAPS this "Twenty-Five Up and Down" test is no better than others in checking objective findings against subjective claims. However, it has proved of value in this respect, and also in estimating roughly the degree of disability when present. The individual with a cardio-respiratory handicap will have that handicap revealed. The proportion of the exercise which he is able to complete will roughly correspond to his physiological efficiency. If he is exaggerating his symptoms or is malingering, the writer knows of no better test for letting his sins find him out. A single example will suffice. Among a group of compensation cases claiming disability was one man who tried to disguise his natural truculence by a too artificial barrage of banter and attempted to hide his lack of willingness to really cooperate by over-cooperating. When he undertook the "up and down" test he worked very hard and exerted a most unreal amount of apparent effort; his breathing became alarmingly labored and he became so completely "exhausted" that he could only raise and lower himself 13 times instead of the prescribed 25. He lay completely worn out, with marked dyspnea—the picture of violent over-exertion. But the tell-tale blood pressure and pulse observations proved all his histrionics to have been wasted. Even his chest-heaving disappeared too rapidly when his attention was diverted by other details of the examination.

Another advantage of this particular procedure is its wide applicability. It is no handicap to those with ankylosed joints in the lower extremities or with amputations. Even the one-armed do it well. Ankyosed spines of course interfere. Perhaps the commonest handicap in its performance is obesity —pot bellies do get in the way—but even so it seems as practical for the obese as do most of the other tests.

One word of warning in regard to its application: neither this nor any other exercise test should be required of any individual with active tuberculosis or known serious cardiac disease. Naturally, such a test is as unnecessary as it would be cruel or even dangerous. There is no point in testing an obviously disabled man for disability. Also the preliminary cardiovascular observations will enable the examiner to waive the test in the occa-

sional case of extreme hypertension, or other significant organic disease where harm might result from its use.

The author offers the "Twenty-Five Up and Down" test as one which he has found useful and which, in his estimation, is more satisfactory than others for rapid physical examination of large groups of men. At the same time it has proved equally satisfactory for consulting room work.

Industrial Gases and Vapors

Some General Methods for Their Sampling and Estimation

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THE collection of gas samples in factory work rooms differs from the collection of ordinary samples in that the component to be estimated is usually present in very low concentrations.** This condition imposes several restrictions on the method to be used. The collection of small samples in bottles is frequently not applicable because containers of suitable size may not be conveniently carried into the field. Special care must be made in the selection of a retaining liquid since serious loss of the component may come about either through solubility effects, chemical reaction or physical absorption. This is especially true of acid or basic gases and organic vapors. In general, if a bottle or tube is to be used, it should be previously evacuated and then opened at the site where the air under study is to be obtained. Even this method is usually applicable only when some absorbing reagent is subsequently to be added to the vessel itself, since the recovery of the gas mixture from the container without changing its composition is awkward, even under laboratory conditions.

The best approach to the problem, when collecting a gas sample, is to take up the gas in appropriate absorbents and vessels at the time of collection. The simplest case involves the filling of a previously evacuated, clean, moist bottle, of known volume, with the air to be sampled, making appropriate temperature and barometric pressure observations and then adding, either in the field or laboratory, an absorbing reagent for the desired component. When the reaction is complete, the reagent is quantitatively transferred from the bottle or flask and a suitable method of analysis applied. This method is applicable for the determination of many acid, basic or oxidizing gases, such as chlorine, oxides of nitrogen, and moderately high concentrations of ammonia, and in addition carbon monoxide. It usually is not convenient to so collect samples larger than five liters in volume, since large evacuated vessels are liable to implode, endangering the operator and causing loss of sample. They usually may not be carried in sufficient numbers.

A more complicated and useful method of sampling involves drawing relatively large measured volumes of air through absorbers or scrubbers and subsequently determining the concentration of the desired component by physical or chemical examination of the absorbent. The gas should enter the scrubbers before being metered or pumped. Metering may be accomplished by use of some type of carefully calibrated flow meter, a gas meter either of the wet or dry test type, or a calibrated aspirating bottle. Observation of the prevailing temperature, barometric pressure, relative humidity and aqueous tension should be made in precise work. If flow meters are to be used, they should be operated through their useful range, at a constant rate of flow and it must be borne in mind that their readings will vary with the temperature of the gas to be measured, its composition and any other factor which may materially alter its viscosity or density. The fact that a relatively dry gas may become saturated with water vapor, or vice versa, in passing through the absorbers must be considered. Movement of the gas stream through the absorbers may be induced by an aspirating bottle, an air ejector, a hand or motor driven pump, a rubber bulb, or some similar device. More uniform flows may be obtained with efficient rotary type pumps, directly driven by impulse start induction motors. Sampling times must be observed with a stop watch unless they are of unusually long duration.

Solid absorbents, such as charcoal or silica gel for water vapor and organic vapors, and ascarite for carbon dioxide, sulphur dioxide, and other acid gases are invariably placed in a glass stoppered "U" tube or other convenient apparatus and its change in weight observed upon passage of a known volume of suitably treated gas through the system.

Liquid absorbents may be used in vessels of many types, but in every instance they must react with the desired gas in such a fashion that the extent of reaction may be readily determined after a suitable sample is taken.

Gas washing bottles appear in many forms,[1,2,3] but may be conveniently grouped into the following five types: (a) ordinary, (b) those with bulbs or pieces of glass at the inlet tube, (c) those with sintered or fritted gas or multi-perforated plates at the inlet tube, (d) those involving atomization of the absorbent with the influent gas and (e) those of spiral design.

Of these types, the sintered or fritted glass and the spiral design[4] are probably the most efficient. If a precipitate is formed, the simpler though less efficient types such as the 10 bulb tube[5] or the familiar Drehschmidt or Drexel gas washing bottles may be preferable. In any case, the bottle used must be rugged and portable in order to meet the severe conditions of field usage. Sampling rates are extremely variable, depending upon the gas to be absorbed, the reagent and the type of bottle, and will vary from five to 500 liters per hour. Practical considerations demand high sampling rates, but the proper rate must be determined individually for almost every condition. A reagent that will absorb rapidly at 25°C. may be only one half as efficient at 10°C., a temperature frequently encountered in factory workrooms.

Another large group of methods utilizes some physical or physico-chemical property of the gas to be detected. Such methods usually allow the use of a mechanical indicator which indicates directly and more or less continuously the concentration of a particular gas present in the sample. Such methods, when applicable are ideal for field work, in that they are compact, portable, sensitive and

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rapid. Unfortunately they have several faults in common, namely lack of specificity, complexity of mechanism, and high cost. They must be calibrated for the particular gas mixture under consideration and when so calibrated will usually permit the detection of only one or two variables in the mixture. These methods can be used only because the oxygen-nitrogen composition of air remains essentially constant and such common interfering variables as water vapor and carbon dioxide may be readily removed.

THIS class of methods may be conveniently grouped into eight types, (a) condensation methods, (b) absorption of charcoal or silica gel, (c) density measurements, (d) viscosity, (e) thermal conductivity, (f) optical methods, (g) spectroscope, and (h) various electrical methods.

Condensation methods involve the liquifaction of all or portions of the gas mixture in a suitable refrigerant, ranging from liquid helium to solid carbon dioxide or even ice-salt mixtures. The several components of the resulting liquid are then separated by fractional distillation, preferably with the use of fractionating columns.[6,7,8,9,10] Such methods are expensive, slow and complex, but are the only practical ones now available for complete analysis of complex mixtures such as lacquer solvent vapors. This procedure fails if minimum or maximum boiling mixtures are formed.

Absorption of a gas component on activated charcoal or silica gel is probably the cheapest, most portable and satisfactory general method for the determination of an organic vapor in air. However, the method is not specific and if a mixture of vapors are present, will usually give no definite information about the concentration of a particular component. Water vapor and carbon dioxide interfere and first must be removed. Extensive literature is available on the use of activated charcoal, of which only the work of Cook[11] and Schuftan[12] is mentioned here.

The measurement of the density of the gas mixture is useful, especially if the density of the unknown component is high, as is the case with an organic vapor, although in the writer's knowledge, such methods are not being used at present in industrial hygiene work. Density measurements suffer the common fault of physical methods in being non-specific. The density of the component to be determined should differ as much as possible from the density of the other constituents. The procedure of weighing a known volume of gas in a bulb [13,14] is simple in principle, but too slow and difficult for technical use if accurate results are to be obtained. The use of a gas density balance as described by Edwards, Stock[15,16,17] and others is more valuable and is in use in certain types of technical gas analysis. The method is fast, reasonably accurate and requires only small volumes of sample.

The static column method[18,19,20] measures the difference in hydrostatic pressures exerted between a long column of unknown gas and a similar column of air. Recording instruments have been developed using this principle, but are not sufficiently portable for field work.

The rate of effusion of a gas through a small orifice, which is inversely proportional to the square root of its density, has been made the basis of an analytical method by Bunsen, [21] Edwards[22] and others. This method gives fair accuracy when the gas under examination is closely similar in physical properties to the gas under comparison.

Since the velocity of sound in a gas is proportional to the square root of its density, application of this principle may be made in gas analysis. An instrument capable of detecting 1% of methane in mine air has been devised by Verbeek[23] and Hurwitz.[24]

The viscosity[25] of a gas mixture, especially when organic vapors are under consideration, may be made a measure of its composition. Under favorable conditions, the accuracy is high, the method simple and only small samples necessary.

An instrument known as the viscosity-effusion bridge[26] is valuable for detecting organic vapors. It depends on differences in the relation of density and viscosity between a gas under study and a reference gas. This instrument is of English manufacture and to the writer's knowledge has not been applied to field air analysis in this country. The suitability of this instrument for field application in the estimation of low concentrations of gas should be investigated.

The thermal conductivity method of analysis is rather widely used in industry, but in its usual form is neither sufficiently portable nor sensitive for industrial hygiene field work. The principle of the method is based upon the fact that a conducting wire heated by a constant electric current loses heat in proportion to the thermal conductivity of the atmosphere about it. The temperature of the wire is than measured by determining its electrical resistance, the latter value being a function of the temperature. The method has been extensively studied by Weaver and Palmer [27,28] and others. In the usual design of the instrument, two cells, one containing the sample and one the reference gas are compared in a Wheatstone bridge circuit, which may be either balanced or unbalanced. A galvanometer and potentiometer are used to balance the circuit Binary mixtures of gases or changes in only one component of complex mixtures may be studied. Extensive redesign will be necessary to make this instrument available for field work.

An interesting modification has been devised[29] for use as a combustible gas indicator. Two cells, fitted with hot platinum filaments, one surrounded by air, the other by air containing a combustible gas, are made the arms of an unbalanced bridge circuit, connected by a rheostat and milliammeter in series. The milliammeter is adjusted to zero with both cells containing ordinary air. When air containing a combustible gas is drawn through the working cell, oxidization of the gas elevates the temperature of the filament, increases its resistance and produces a deflection of the millimeter, which may be calibrated directly in percentage composition for the gas under study. The apparatus is compact, portable and sufficiently sensitive for use with most combustible organic vapors, especially those of the petroleum series. A multi-range milliammeter may be used, making possible the study of explosive limits as well.

The difference between the indices of refraction of the various gases is very small, thus the problem of differentiating between them by measurement of this constant becomes difficult. Such small differences may, however, be measured

with satisfactory accuracy by means of an interferometer,[30,31] especially designed for gases.

In practice, the difference in refractive index between two gases in adjacent tubes is measured, one tube containing a reference gas. Portable gas interferometers are available[32] with cells of different lengths, capable of detecting carbon dioxide, methane or hydrogen in air with an accuracy of 0.2%. These instruments are portable and provide accurate and rapid results. They are suitable for grab samples of binary mixtures and complex mixtures containing only one component of interest. The high cost of an interferometer limits its availability to most laboratories.

The methods of spectroscopy have been used for the estimation of small concentrations of certain gases, but as yet they are not generally adaptable. In most instances, a sample of the gas mixture must be brought to the laboratory for study. Discharge spectre have been successfully applied to the identification and estimation of certain fixed gases, but the methods are of little interest to the industrial hygienist

Absorption spectra may be successfully used in the determination of small amounts of gases such as nitrogen peroxide,[33,34] nitric oxide[35] and ozone. It is possible to detect as little as 0.001% nitrogen peroxide by this method. Infra-red absorption spectra have been applied to the determination of methane, methyl halides[36] and carbon dioxide.

In general, spectographic methods are not commendable, due to the high cost of equipment, the difficulty of technique and the limited applicability. The same objections govern the use of various electrical methods.[37]

Physical methods of analysis as a group are satisfactory for the examination of atmospheric air in the field, in that they are sensitive to low concentrations of gases in mixtures. Further, they frequently are direct reading, portable and do not require a high degree of technique or skill for their operation. On the other hand, they are non-specific, limited in scope and costly.

Occasionally a chemical and physical method may be combined with good results. Carbon monoxide when passed over a suitable catalyst will be oxidized by atmospheric oxygen. The heat of reaction is measured by a thermopile and recorded on a milliammeter which may be calibrated directly in percentage of carbon monoxide. The instrument is sensitive to 0.005% carbon monoxide.[38,39] Reducing gases like ethylene may interfere.

Halogenated hydrocarbons such as carbon tetrachloride decompose in the presence of water vapor and high temperatures with the formation of hydrogen chloride. A simple device,[40] called a "Halide Leak Detector" oxidizes any halogen compound in the flame of an alcohol blow torch, impinges the products of combustion upon a heated copper spiral and obtains the characteristic blue-green copper flame, the intensity of which is roughly proportional to the concentration of halogen present. Gases containing sulphur or strong acid constituents will interfere.

Summary

FOR the purposes of sampling and measuring industrial gases and vapors, a wide variety of methods and procedures is available, no one of which is universally applicable. Some of these divers methods and procedures briefly are described and the conditions under which they may be most effectively utilized are mentioned. An extensive series of citations is provided, in which publications there may be found precise descriptions of the appliances, methods and practices mentioned in this publication.

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Industrial Hygiene Laboratories

—*And Their Work*—

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ANY discussion of any individual section of industrial hygiene laboratory procedure must include some means of collection of a sample.* Some instruments and methods are so devised that such samples are automatically recorded as a dial or scale reading in percentages of the constituent under examination or some simple reading which may be readily translated into terms of percentage. These we properly call field methods even though a fair amount of calibration must still be performed in the laboratory. Other substances and materials must be first collected, then isolated, and finally determined by some physical or chemical means in the laboratory.

Solid Contaminants of the Atmosphere

IN THE examination of solid contaminants of the atmosphere, we use both field and laboratory methods. We propose to break the explanation of this phase of an industrial hygiene laboratory's work into the following parts:

First, a discussion of those methods which for any material leads to the laboratory before an answer can be given;

Second, a discussion of any possible instruments which might be used to attain a more direct answer.

To maintain some semblance of form, we will discuss in order the non-metallic dusts as silica, asbestos, etc., and then the metalloidal and metallic dusts.

Non-Metallic Dusts

THE most accepted means of collection of solid substances is the motor or ejector driven air sampler utilizing the Greenburg-Smith impinger.[1,2,3] We have used an air sampler of Dr. McCord's design[3a] with good results. (Fig. 1) This machine is simply a means of collecting a known volume of air. The instrument is calibrated, using an accurate dry test meter whereby the readings

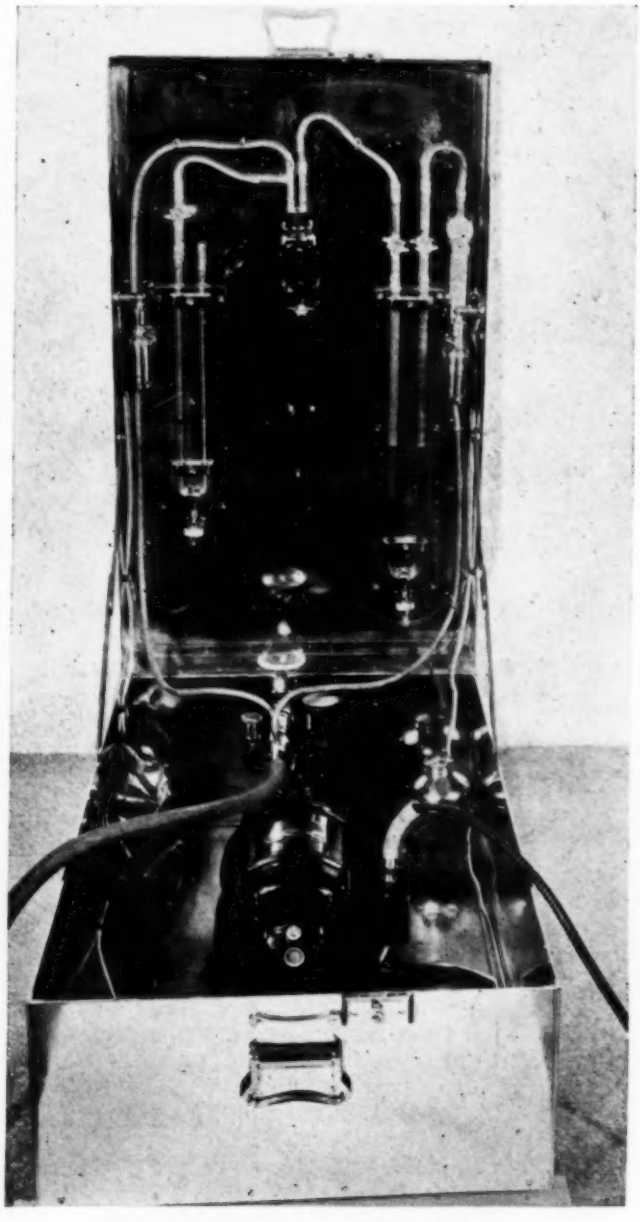

Fig. 1. Dust Sampler of McCord design

on the gauges are determined and proper curves plotted. In order to avoid a complete calibration every few days, as is necessary with a calibration which uses the formula $V = CO\frac{H\ P}{T}$ where:

V=Volume in cubic feet at 68°F. and 30″ Hg.
C=Constant (dependent upon set up used).
O=Time in seconds.
H=Aneroid barometer pressure minus the difference between the mercury level before and after the start of each sampling).
P=Oil gauge reading (difference between upper and lower levels).
T=The Fahrenheit absolute temperature (t°F. obs./ 460).
(The constant C must be determined for every change in the sampler, including the plugging of the impinger if such a formula is used).

for calculating the volume of air drawn by the air sampler, we have set up a master calibration

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system. Using this master chart cuts the time of calibration to a few minutes' work once a week. Details of this time saving method, which is helpful in extending the use of the machine to the collection of materials which may plug the impinger, without changing any portion of the system, are as follows:

The machine is set up exactly as for sampling work, and a tested dry meter is connected to the impinger. The machine is started, and, by regulating the bypass needle valve, the machine is regulated to pump a definite quantity of air per minute; in this case, 1 cubic foot. Ten cubic feet of air is taken as the test unit. The mercury and oil gauges are read when a ft^3/min. is passing through the machine. Air volumes are reduced to standard conditions of temperature (68°F.) and pressure (30″ Hg.). The oil gauge is maintained at its proper position by regulating the inflow of air through the needle valve. If the impinger is plugged, the mercury gauge gives a higher reading. Therefore, in calibrating the machine, we proceed to introduce conditions similar to those encountered in practice. This is done by putting a screw clamp on the line between the impinger and pump; the constriction formed by the clamp places a resistance in the line similar to that offered by a dirty impinger. The mercury gauge readings are checked by the above procedure, and a graph of mercury gauge readings against seconds/ft^3 is then plotted. In actual sampling, the oil gauge is maintained where desired according to the calibration (1 ft^3/minute) and the mercury gauge reading is noted. · The mercury gauge reading on the calibration graph indicates seconds/ft^3, and the volume in cubic feet per minute is noted. Providing the machine is not disturbed by replacement of tubing. change

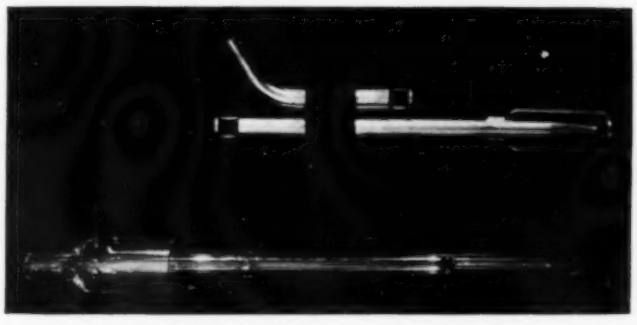

Fig. 1a. Glass and Metal Impingers

of orifices, etc., it is not necessary to calibrate more than once a week when in constant service. Over a period of a month during rather constant use, it has been found the error is less than ±2%.

The characteristics of the impinger are discussed at length in several publications and need not be entered into here.[4,5] The known amount of air is impinged out into either water, alcohol, or some other liquid media. The liquid used in a given case is that one having the least dissolving effect[6] on the dust if a particle count is to be made, as in the non-metallic dusts. For other substances where a chemical examination is to be made, a liquid is chosen which will dissolve the substances in question.

After the collection of the materials from contaminated air, these samples are brought to the laboratory for counting. The counting should be done within 12 hours[6] due to the solubility of finely divided silica in water. The bottle of liquid containing the dust particles is diluted up to a definite volume of from 250 to 500 ml. If a large number of particles are believed to be present, some portion of this 500 ml., well shaken, is again diluted to a known volume.

Rather than use screens to separate out all particles over 10 microns in size, we have adopted the practice of allowing the thoroughly shaken bottle to stand for 12 minutes. According to Stokes' law[7], we will lose by settling the particles of more than 10 microns. Then the top portion of the liquid is poured over the counting cells as a wash and the cell filled from the middle third of the sample. Further details may be found in an article by J. J. Bloomfield[8].

The cells used in counting are either the Sedgewick-Rafter cell with a 1 c.c capacity and 1 mm. depth, or the Hatch[9] cell with a ¼ mm. depth. The Sedgewick-Rafter cell is the most commonly used. If one uses the Hatch cell, care should be taken to check results on the same samples with the Sedgewick-Rafter cells until comparable results can be attained. The original article would have one count particles as low as .3 micron in size and this is not agreed on by a majority of those in the field.[10] After filling the cell, the particles are counted, using a microscope with a 10X objective and 10X eyepiece. For determining particle size, it may be better to use a 200 magnification with a 20X eyepiece and 10X objective.[11] While the public health work done by Bloomfield[8] specifies the use of a light field, it is difficult to count particles by this method. We have found it advantageous to cause a modified light field by the insertion of a dark field stop below the iris of the microscope. This does not cause a dark field in the true sense of the term but does cause a shading of the field so that the particles can be readily counted. Values obtained in this way are conservative but not entirely out of line with true light field counts.

Method of Counting

IT IS obvious that scrupulous care must be exercised in the preparation of all glassware. An ordinary microscope with an Abbe condenser and a substage lamp shield with daylight glass are used. The actual counting is done with the aid of an eyepiece micrometer called the Whipple grid. This is then calibrated with a ruled standard such as a stage micrometer, and the draw tube of the microscope adjusted so that one side of the Whipple disc is 1000 microns, making each of the 100 medium sized squares 100 microns on a side. One medium square in the center is divided into 25 smaller squares so that each is 20 microns on a side. Five to 10 quarters of the whole disc are counted and averaged. To arrive at the total number of particles per cubic foot, one multiplies this average by four to get a whole field, then by 1,000, as that is the portion of the 1 ml., in the cell examined by the field, and then by the aliquot portion of the total sample as 500, if 500 c.c. was the final dilution or 10,000 if that were the final dilution. This is divided by the number of corrected cubic feet of air to get the number of particles per cubic foot of air.

$$\frac{4 \times 1000 \times \text{total volume of diluted sample}}{\text{Volume of air (corr.) sampled in cubic ft.}}$$

By this procedure, particles .7 micron as a lower limit may be seen. This is as low as one cares to go on the basis of available evidence that particles below that size are probably not of industrial origin.[12]

In addition to this procedure which is standard in this country, we have several other methods which involve laboratory examination. Some of these, such as the sugar tube,[13] Palmer water spray[14] and the Anderson and Armspach[15] dust determinator method are of historical interest only. The sugar tube, first used as a means of collecting bacteria,[13a] operated on the principle that the dust would be separated out in going through a tube filled with sugar. Then the sugar was dissolved and the dust particles counted in a Sedgewick-Rafter cell. After subtracting a blank, the efficiency was roughly half that of the impinger. The Palmer apparatus depended on the dust being separated from the air when passing through a spray of water. The dust determinator measured the increase in pressure when air was forced through a filter paper.

Some idea of the number of methods in use for collecting dust can be had when it is noted that Knowles[16] describes 53 such methods, and Greenberg[3] gives a discussion of a large number of the various types of methods. His bibliography of 79 references is almost wholly concerned with the various kinds of dust sampling devices.

Another instrument still used for the collection of explosive[17] and radioactive[18] dusts utilizes a paper thimble. In the thimble method, a holder for a paper or alundum thimble is attached to a motor and air drawn through the thimble so that a sample which may be dried and weighed in the laboratory may be collected.

Another laboratory method involves the use of the Tyndal beam[2] when departing from accepted procedures in order to check the validity of the methods introduced. It consists of matching Tyndal effects when a stream of dust of known concentration is matched with the stream of dust from the instrument to be tested. That is, the known dust content is reduced to the point where it is equal in concentration to the unknown dust content leaving the instrument. When the condition obtains, we have equal amounts of reflected light which can be measured by optical methods.

In addition to the counting of dust particles, it is very important that one determine the size of the dust, inasmuch as only those particles from .7 to 10 microns are thought to be causative of lung impairment which might possible lead to tuberculosis.[19,20,21,22,23,24,25,26] It is often important to know the proportion of particles of definite sizes. For this purpose, a micro projector[27] is of great value due to the lessened time and effort involved. The basic idea is the magnification of the particles upon a screen ruled into areas of known size. The high magnifications are attained by increasing the distance from the microscope to the screen rather than using extreme high power objectives.

A further method of measuring the size of dust particles is that used by the U. S. Public Health Service.[28] This method utilizes the Owens Jet dust counter[29] to collect a dry sample. The Owens jet dust sampler draws a 50 c.c. quantity of moistened air through a jet and then out through another channel at right angles to the previous direction. The pressure drop from going through the jet results in a condensation of moisture on the particles of dust. The particles being unable to change direction are impinged on a glass plate and dry. The result is an unchanged set of dust particles which are then examined by an eyepiece micrometer under a magnification of 1000 diameters. At least 200 dust particles should be measured from each sample. The path left is a long narrow band. The total count can be performed as well as the accurate measurement of the particles for size. This method of measurement, which involves the use of a calibrated eyepiece micrometer inserted in the tube of the microscope, is somewhat more tedious and time-consuming than the use of a micro projector.[27]

Since dust enumeration and particle size determinations do not tell the chemical composition of the dust, one must in a complete study analyze the materials. Thus, in the case of dust containing silica, one could not expect a dust of 30% silica to be as harmful as one of pure silica. The separation and analysis of silica in a mixture also containing silicates is very difficult to perform accurately. One method of attack is to analyze for all the metallic constituents and all the silica, then through the empirical formula determine the percentage of free silica.[30] For reasonably accurate results, one must further, through determination by petrographic means,[31] determine the original kinds of minerals present. The petrographic microscope differs from an ordinary one in that Nicol prisms provide a source of plane polarized light. (Fig. 2). For the examination of dusts, one also needs a set of liquids with known indices of refraction. These liquids are prepared and checked with an Abbe refractometer to give the indices desired.

Another method is to treat the sample with acid and remove the acid soluble components, then remove the organic matter by ignition and finally determine the free silica due to its preferential solubility in some acid such as fluosilicic[32,33] or fluoboric acid.[34]

Another recent work describes the use of an x-ray diffraction[35] method. This last method will probably give good results, but the expense of the equipment will retard its use.

Field Methods

IN ADDITION to the purely laboratory methods, we have in common use field instruments for the determination of dust quantities. While many of these instruments require laboratory work, we may properly call them field instruments due to the greater portability of the equipment. One of these is the Owens Jet Dust Counter previously shown, which may collect the sample for laboratory examination, or in a modification such as the Bausch & Lomb Konoscope one may count the dust particles while in the field. This advantage is gained through the attached microscope and lamp. It should be borne in mind that this instrument was developed for the enumeration of atmospheric dusts and may not be ideal for industrial usage. The matter of changing humidity also has effect on the constancy of results. Furthermore, the instrument even in skilled hands begins to give results of questionable accuracy above 50 million particles. It has been considered that such an instrument may have

some value in the testing of home air conditioners.

Another field instrument, the konimeter[36], has a limited use under certain conditions. This instrument has a plunger for collecting a measured amount of air which is relieved of its dust content through impingement on a prepared glass slide. It has the advantage that a number of samples can be collected and read directly in the field, if the instrument is equipped with a microscope. The disadvantages are that this is a grab sample and numerous tests would have to be made to prove that the conditions were normal to the time and place under examination. It

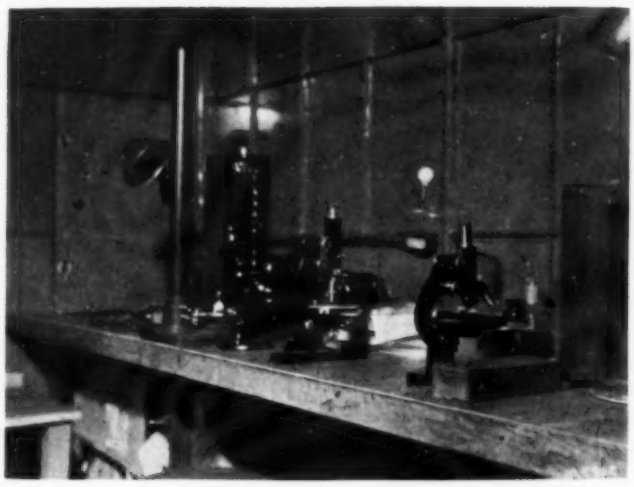

Fig. 2. Analysis of Dusts in Chrysler Industrial Hygiene Laboratory. From foreground back:

a. Dust counting microscope
b. Petrographic microscope
c–1. Abbe Refractometer
–2. Temperature control for Refractometer

is furthermore true that for air containing more than 40 million particles of dust per cubic foot the results deviate from actuality.[2]

It must be admitted that, as a rapid means of conducting preliminary examinations of dusty areas, the konimeter is of value particularly if the count is low. A difficulty to be guarded against is that silica dust due to its index of refraction is very difficult to examine on the konimeter plate. This is not true of coal dust, iron dust, and other dark particles.

Among the more recent developments, we have what are called thermal precipitators, electrical precipitators of various sorts, photographic recording of dusts, and sedimentation cell methods.[37] After touching on the other developments, we will discuss more fully the thermal precipitator and electrical precipitator as having shown the greatest possibilities of usefulness.

A recent development is the photographing of dust particles on a plate in order to preserve a permanent record.[38] We have here all the difficulties previously mentioned as applying to grab sample plate impinging methods, plus the additional factor of the spotting of the photographic film. If all the possible errors are given due consideration, this device has considerable merit from the standpoint of permanent records of a condition existing at some past time.

Various devices have been made from time to time utilizing the idea that a previously charged particle can be precipitated by an oppositely charged surface. Commercially, it has been used in the form of Cottrel precipitators. The same idea has been used in instruments designed to trap all the dust from air samples to count or analyze the particulate matter.

The electrical precipitator as modified by Drinker[39] could be classed as a field instrument though the dust must be taken to the laboratory for counting or analysis. This instrument is a valuable device for sampling smoke and fumes.

The instrument consists of a wire through a tube and connected to a source of alternating current. Strips of metal are wound about the outside of the tube and given an opposite charge to that of the wire. The dust settles out on some collecting surface such as cellophane and is transported to the laboratory for examination.

A very recent article[40] gives the details of an electrorotor apparatus developed by Blacktin, in England. The principle involves an automatic and sychronized operation combining rotation, suction, electrification and centrifugal action. The motion of a pump handle drawing in the sample of dusty air rotates an electrifiable disc which collects the dust in a circular pattern of variable size. Due to the small amount of work done with this apparatus, it is too early to judge as to its place in the industrial hygiene laboratory.

The thermal precipitator[12] is essentially a method for causing a small measured volume of air to pass an electrically heated wire. The dust is collected on cover slips and counted under 1500 diameters magnification. The instrument is efficient in collecting practically all the particles, but it is not certain that we should evaluate atmospheric dust rather than industrial dust[12] which appears to be of somewhat larger size than those counted by Green's method.

The most promising recent development concerns the electrostatic dust sampler. This we wish to describe fully because of the several uses to which the principle is being extended. The basic idea is: In the electrostatic dust sampler developed by Barnes and Penney,[41] electrons from a wire at high negative potential ionize the surrounding air. The electrons are repelled and, in drifting through the adjacent space, give a negative charge to the dust particles which then are attracted to the oppositely charged wall of the instrument and there deposited. An opening in the side wall contains a conducting slide which receives a proportionate share of the dust. These slides are then counted in the laboratory. Other applications of this principle will be treated in connection with another phase of the hygiene laboratory's work.

These recently described methods have high efficiencies in regard to dust collection. It is probably true, however, that they can not be truly evaluated due to the lack of uniform standards of counting and also to disagreement that exists as to what should be counted. Until more complete evidence is available, the standard practice will involve the collection of the dust by the impinger and the enumeration of particles by the U. S. Public Health Service method.

Metalloidal and Metallic Dusts

THE treatment of metallic dusts in practically all cases demands the preliminary collection of a sample and subsequent analysis in the labora-

tory. While we cannot illustrate the method of attack of all possible substances, we will endeavor to explain how the major toxic metallic dusts are handled. It has been found that the impinger method of air sampling is satisfactory for most chemical substances in dust or fume form provided a proper solvent is used as liquid media. Normal methods of sampling technique are employed where contaminated air is not the major consideration.

A number of methods useful to industrial hygiene work have been published by[42] W. A. Cook. While most of these methods are satisfactory, we wish to add a few very recent methods which we believe from laboratory tests to be extremely useful.

Arsenic—Collect by glass impinger in alkaline solution. Analyze by modifications of Gutzeit method.[43]

While it is believed that antimony merits some attention, no completely satisfactory method adaptable to our work is known.

Cadmium—Collection in weak potassium hydroxide solution. For quantities above .04 milligram, it is best to analyze with the colorimetric sulphide method under ultra-violet light.[44]

We have developed in the Chrysler Industrial

Fig. 2a. Heavy Metal Section of Chrysler Industrial Hygiene Laboratory

Hygiene Laboratory[45] an unpublished method using dithizone for the estimation of quantities of cadmium with a top limit of .04 milligram in which quantities of less than .0001 milligram can be estimated with sufficient accuracy for industrial hygiene purposes.

Hexavalent chromium is collected in weak alkali. It is best determined in small quantities using semi-diphenylcarbazide as an indicator.[46]

Lead, as the metal having the most extensive and varied uses and which causes the greatest economic losses, should receive special recognition. Though a large amount of work has been performed by numerous investigators, it is only recently that a chemical means has been found to accurately and rapidly determine small quantities of lead. It is believed that the use of diphenylthiocarbazone will materially aid more complete studies of the lead problem in its many phases. We have used for some time a modification of the dithizone method and have attained remarkably good results. The method involves the collection of a sample in water or dilute nitric acid and the subsequent analysis with dithizone reagent.[47] The results compare very favorably in accuracy with the spectroscopic method and do not require expensive equipment. Furthermore, the method is much more rapid for air analysis than any other known method. (Fig. 2a).

Manganese is collected in alkaline solution and analyzed by the permanganate colorimetric method.

There are a number of satisfactory methods for the determination of *mercury*. An apparatus sold by General Electric was developed by Norlander.[48] In this equipment, air is impinged against selenium sulphide which is darkened and compared to a standard. Other methods such as that of Stock and Cucuel[49] and Fraser[50] are also believed to be satisfactory.

Recently, Winkler[51] has published a method for the determination of very small quantities of mercury using diphenylthiocarbazone as a reagent which is very rapid and satisfactory for some industrial hygiene purposes.

Iodine is best collected in 10% potassium iodide solution with the aid of a fritted glass bubbler and analyzed with standard thiosulfate solution.[52]

Radioactive materials will not as a usual thing be encountered in the industrial hygiene laboratory. A complete study has been made by the U. S. Public Health Service.[53]

Before leaving the subject of the strictly laboratory treatment of solid substances, we wish to indicate that the very small quanities available for analysis have made it a future requisite that micro-chemical equipment be a part of a complete industrial hygiene unit. The discussion to this point has dealt almost entirely with air analysis. We have indicated that the greatest difficulties have attended the work because of the small quantities available for examination and the lack of sensitivity and selectivity of some of our known methods of attack. This situation is equally prominent in the study of those substances and mixtures normally gaseous or liquids when considered as atmospheric contaminants. This will be further discussed in another paper.[54]

When some other phases of the laboratory's work are considered, it appears more vital than ever that micro-chemical procedure be adopted wherever possible.

In modern industry, new products are put into use constantly. Many of these products are trade products and the only possible way to determine the constituents is by chemical analysis. Inasmuch as some constituent which is present in small amount is usually the offending agent when difficulties occur, we have found it advisable in some cases, at least, to treat the separated fractions with micro-chemical methods of attack. It is furthermore true that there are times when the samples available, such as may be taken from a workman's glove, are very small.

Such instruments as the spectrograph give micro-chemical answers even though not classified as a micro-chemical instrument. In some cases, it is probable that the instrument would prove of such value as to negate its high first cost. In the determination of many toxic substances, such as arsenic, manganese, lead, chromium, mercury, silica, and their compounds, we may use some colorimetric method. Colorimetry is another

means of getting a micro-chemical answer and, in view of its importance in industrial hygiene work, we have used a photometer in preference to the ordinary type instrument usually called a colorimeter.[55] (Fig. 3). For accurate and rapid work, it is better to use such an instrument since with it

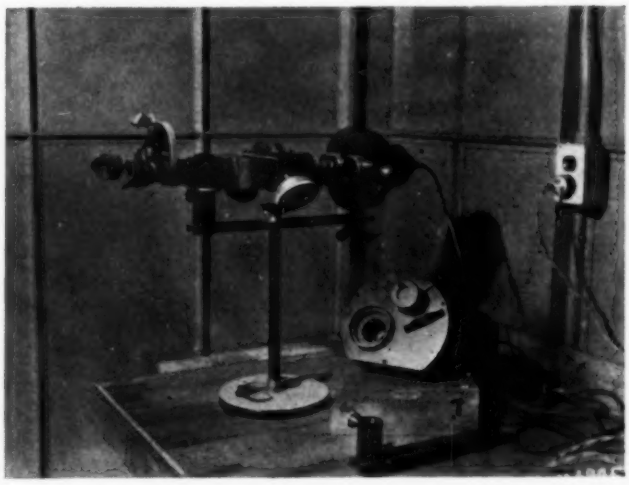

Fig. 3. Photometer with Nephelometer. Attachment on box. Chrysler Industrial Hygiene Laboratory

you measure the stimulus rather than the sensation. That is, one measures the definite colorimetric impulse in terms of transmitted light or absorption co-efficient rather than comparing the difference in shade of a color. The time factor alone makes the extra cost economically feasible if any number of determinations are to be made.

A further development of the idea of getting micro-answers is found in the use of the interferometer, through the determining of index of refraction. (Fig 4). When the Abbe refractometer fails to give a decisive answer, we can extend our measurements accurately for three more

Fig. 4. Interferometer in Chrysler Industrial Hygiene Laboratory

decimal places or to 10^{-7} by using this interference of light principle.

These and other means of attacking the question of the small sample are further justified when one considers the time and effort often involved in collecting the materials to be analyzed.

For the above mentioned reasons, we have included a moderate amount of truly micro-chemical equipment (Fig. 5), such as apparatus for determining molecular weights, halogens, sulphur, carbon hydrogen and nitrogen, arsenic and several other elements. Apparatus for micro-extractions, centrifuging and weighing have also proved to be of value.

In the qualitative determining of substances by means of chemical examination under the microscope, it has been found that answers can some times be given which would not be available in any other way.

Another use for micro-chemical equipment is in the examination of various types of cleaners used by workers in industrial areas. While it may, or may not, become a problem of the laboratory to devise cleaners which will not add to the dermatitis problem, it is some times important to analyze these cleaners in view of the number of such cleaners on the market which are skin hazards.

Ventilation

AFTER the hazard is determined, the next step is the study of the prevalence of the condition and a devising of a general means of attack.

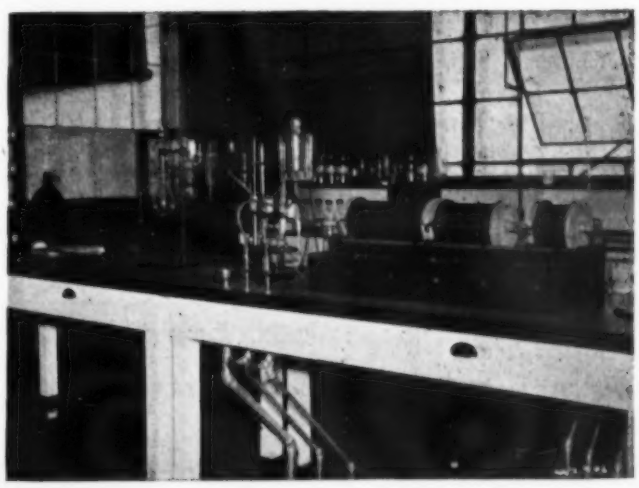

Fig. 5. Micro-chemical Section, Chrysler Industrial Hygiene Laboratory

For practically all problems where the atmosphere is the carrying agent, equipment such as an anemometer, katathermometer, Boyle velometer, pitot tube, psychrometer, tachnometer and pressure gauge is required to ascertain the possibilities of such conditions through ventilation. Thus, if ventilation equipment is already in use and high concentrations of contaminants are present, tests should be performed on that ventilation equipment to locate the difficulty. It must not be construed that the industrial hygiene laboratory in any way takes over the engineering problem of installation of equipment of proper design, but, where the laboratory does use such testing equipment, it is to the end that intelligent recommendations can be made as to the propriety of such engineering installations. This requires some knowledge of modern studies[56] on hoods and general ventilation.

The low-speed anemometer has its place in the study of general air conditions and velocities existing at hood entrances. The velometer has a wide range of velocities and is valuable in testing gratings, ducts, etc. The pitot tube as an instrument for measuring static and total pressure is valuable in the study of ducts of various sorts.

The psychrometer and katathermometers are required when some problem affecting the comfort of the worker is involved. Thus, where air supplied respirators are used, it may be necessary to determine whether or not the air supplied is too dry or too moist.

The use of the various katathermometers, heated globe thermometers, etc., as discussed by Yaglou[57] shows the numerous difficulties inherent in attempting to measure comfort conditions and no laboratory work would indicate that a dogmatic attitude can be taken. Recent articles on the subject of air conditions in industry[58], hospitals[59], and in public and home life[60] have been written by Yaglou, Drinker, and others.

In view of the tremendous development in air conditioning, it is of interest to show the application of the electrostatic principle, previously mentioned as a dust collecting instrument, to the air conditioning field, where commercial installations are using the method to save valuable ceramic dusts.[61,62] The application of the idea to home air conditioning units by the Westinghouse Company is also noteworthy.

A topic which is closely related to air conditioning but seldom mentioned is the determination of odors. A recent method[63] shows promise of helping solve such problems as were presented to the Hygiene Survey of New York City. The problem confronting these laboratory workers was to determine what made persons ill on buses when they were reasonably sure that carbon monoxide was not the offending poison. They believed, but have not been able to prove, that some odorous aldehydes were causing trouble. The work of Grant and Shaw[63] would indicate that some further light can be thrown on such problems by the use of a freezing apparatus and the Fair[65] osmoscope. The osmoscope is a device for diluting odoriferous gas mixtures with known volumes of air until the odor is just detectable to the observer. In this way, relative odor values may be determined after freezing out the odoriferous constituents and collecting them for analysis. New and more quantitative instruments and methods are needed to evaluate odors, as many of the irritating problems, and some serious ones, of the worker in this field are due to substances stimulating the olfactory nerve endings.

In addition to the topics previously mentioned, there are a number of unrelated subjects which involve some portion of the industrial hygiene laboratory's time. One of these subjects is not often considered in thinking of the industrial hygiene laboratory, namely:

Hearing

THE present trend is to consider noise as much an evil as polluted air. The audiometer enables the industrial hygienist to study the effects of various noise conditions or the hearing of the persons so exposed. In addition to individual tests on all those exposed in a given area, it is then possible to take a noise meter to the area and determine the total volume of noise. As is well known, the audiometer will reveal the possible partial or complete loss of hearing in one or more frequencies with the subject able to hear very well in other frequencies. The Chrysler engineering staff have developed an interesting instrument[66] used in testing cars which, as far as we know, has never been previously used in the industrial hygiene field. This instrument or collection of instruments will not only enable the total intensity of noise to be determined but will permit the analysis of this noise into the amounts due to the various frequencies. The study of the intensities of the various frequencies will enable the investigator to determine the noise producers. It is from such an analysis that the proper changes can be made in order to lower the total intensity of noise or to remove the factor causing the noise which is particularly harmful. The economic advantages of treating the problem this way instead of haphazardly attempting to remove all sound are obvious.

An audiometer consists essentially of a vacuum tube oscillator which produces a series of pure tones. These tones are amplified, their intensity measured in decibels and then observed through head phones by the subject under test. In this fashion, with the cooperation of the subject, the threshold of hearing expressed in terms of decibels may be determined, compared with that of the normal ear, and the degree of deafness to the various frequencies evaluated. A modification of this audiometer may be applied to group studies.

The noise tester generally includes a microphone, an amplifier, and a milliameter which may read directly in decibels. These instruments may be equipped with band filters, which permit the separation of the various frequencies of vibration into several groups or in some instances into pure tones. This separation, which increases the complexity and cost of the apparatus, may prove essential since there is evidence indicating that different frequencies of the same intensity level have varying damaging powers.

Illumination

SOME recent[67] work has been performed on light intensities. Laboratory instruments may use some means of comparing light of unknown intensity with a source of standard intensity.

For field work, a highly portable foot candle meter has been developed.[68] The illuminometer employs the photo voltaic cell and a milliammeter graduated to read directly in foot candles. Attachments are available for the interferometer which enable intensity and glare to be determined.

Special Procedures

THE work of the industrial hygiene laboratory can also include a number of aids to the industrial physician which are not commonly available in all clinical or hospital laboratories. Such methods as Christman and Randall's[69] in which carbon monoxide is liberated from a small sample of blood and determined colorimetrically after reaction with palladium chloride solution, McCord's[70] method of determining lead absorption by means of the basophilic aggregation test, and various means of accurately determining the amount of lead in urine[71,72] are all valuable diagnostic aids. The determination of silica[73] and of inorganic sulphates[74] in urine are other examples. The determination of inorganic sulphates has been worked out to give some measure of industrial benzol exposure. These represent only a part of the special procedures which a complete industrial hygiene laboratory is called upon to perform.

Conclusion

THE discussion presented indicates that the laboratory is a tool of the industrial physician and engineer. More than that, however, the industrial hygiene laboratory is an entity which should have the needs of the production departments in mind. The constructive criticisms of work areas should involve the suggestion of substitute where some useful substance or method has to be eliminated or modified. Since the ultimate end of our endeavors is the elimination of industrial health hazards or the improvement in environment for the worker, we should make a special effort to remember who pays for the improvements made. By this, we mean that the industrial hygiene laboratory should have as one purpose a careful consideration of all factors of the problems presented so that no unnecessary expenditures are made for non-existent hazards. On the other hand, every effort should be made to procure adequate expenditure where needed. This is fully as important as preventing unnecessary spending, as the rising intangible costs of the insurance type will soon show.

Summary

WE HAVE presented a discussion of the laboratory's work with the various solid substances involved. In addition, we have presented some of the recent developments in the laboratory's work from the standpoint of new methods and responsibilities. Mention has been made of the work done in connection with ventilation, odors, and air conditioning, as related to solid contaminants in the atmosphere. A few of the other activities which the laboratory might be called on to investigate, such as noise, light, and special physiological methods, are discussed from the standpoint of some of the most recent work in those fields.

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Injection Treatment of Hernia

—*In Relation to Industry*—

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THERE is no doubt but that industry is severely handicapped by the fact that there are six million untreated cases of hernia in the United States. It is true that all of these six million cases are not directly connected with activity in industry, but a great many of them are. Medical records are full of serious consequences from strangulations which occur during working hours and sometimes may cause rather severe damage of an industrial nature as well as the compensation necessary to the individual who is so stricken.

There are three different methods which may be included under care and treatment of hernia.

1. Surgery.
2. Application of truss. (This is really not a treatment but can be classed as a means of palliation.)
3. Injection treatment.

Surgery has been the method of treatment that has been most popular. This may be due to various causes. Among these can be listed the classic treatise of Dr. Halstead in 1873 which was immediately acclaimed, and with various modifications, such as those by Bassini, Andrews and others, has remained in great favor. According to statistics of compensation insurance companies the rate of recurrences has been between 18% and 25%.

In compiling a list of reasons patients gave for refusing to undergo surgical treatment, the following are prominent.

1. Fear of surgery.
2. Loss of time — not only the customary two weeks of hospitalization, but the following eight or 10 weeks of incapacitation.
3. Organic conditions which would contra-indicate surgery.

A fourth heading might be made under the title of recurrences. This subdivision recalls a statement made by a well known surgeon who said: "Recurrences are not only embarrassing but when another operation is mentioned to the patient he loses the patient. Then the patient usually takes a great delight in berating the surgeon to the laity at social gatherings, etc., never once taking into consideration the fact that the recurrence very often occurs even after a perfect surgical process."

Under the second form of treatment, namely, the application of a truss—the results naturally are not of any consequence except that in most cases the hernia is aggravated, especially after a long period of time. There are isolated cases where the pressure of the truss caused adhesions to form in the canal and the hernia seemed to have been improved, but as against these isolated cases, there are many cases where the irritation has caused strangulation due to partial impairment of the circulation because of this pressure.

In the third form of treatment, namely, the injection treatment, we have a method which is ambulatory, with no loss of time from work, no

incapacitation during or after treatment is completed, and no anesthetics with certain solutions. In this form of treatment the use of a truss is of the utmost importance. The injection treatment of hernia dates back over 100 years, but the ambulatory nature of this treatment really started when Dr. I. Mayer advocated the fitting of a truss to a patient prior to the use of the injection method. The wearing of the truss continues throughout the course of treatment and for a period of time after the treatment is completed.

A discussion of the types of trusses is beyond the scope of this article as that is a subject, which, to be dealt with in all fairness, would require a complete article by itself.

"WHY HAS the injection treatment of hernia not become more popular?" is a question which undoubtedly has arisen in the minds of a great many physicians. To answer this the history of the injection treatment must be understood. In the *Medical Record* of March 17, 1937, the history is summarized on page 238. To be brief, it can be said that at first this method was very brutal and heroic as it was accompanied by severe pain and necessitated the patient being bed-ridden for weeks. This method was also seized upon by illegal practitioners who used it incorrectly, and as a result deaths were reported. At the time of these deaths Dr. Halstead's surgical method was popularized. Dr. Mayer's contribution came in 1900, and therefore this present method really dates back to that time. It is only in recent years that hospitals and medical schools are undertaking a study of this method, and undoubtedly this will be the impetus needed to popularize this method.

The method of repair is the same in surgery as it is in the injection treatment, namely, a proliferative process of repair. In surgery the sac is also removed whereas in the injection treatment this cannot be done. With the injection treatment the proliferation can be controlled. In this way if one finds that the area over the internal ring is not strong enough a few extra injections can be given and the proliferation is increased—resulting in a thicker and firmer scar tissue.

The technique has been described very ably in a great many papers which are listed in the bibliographies. Nevertheless, the injection treatment requires fully as much skill as a radical operation and an equal knowledge of anatomy. In the state of Arizona the Industrial Commission has made a careful study of the injection treatment of hernias, both from the economic standpoint and the treatment standpoint. Their findings are best expressed in the following paragraphs from a letter by Dr. R. F. Palmer, Medical Adviser, Industrial Commission of Arizona, to the author of this article.

"From the experience we have had, we are not yet satisfied that this method of treatment can be used *generally* by the industrial surgeons of the state in such a manner as will accomplish our purposes. We are convinced however, that selected hernias can be closed successfully without loss of time or expense, other than the cost of treatment and material, if sufficient attention to details is carried out by the surgeon. We are also convinced that the average individual surgeon will not give sufficient time and attention in these cases to make the treatment generally applicable in industrial cases."

"While the original estimates of costs are undoubtedly too low for this class of work, nevertheless, we feel that a tremendous saving in the cost of hernia repair can be had, provided the treatment is properly carried out. *We believe that eventually we will be able to develop key surgeons in this part of the state, who will investigate and acquire proficiency in this method of treatment, and that a great proportion of our cases can be handled in this manner.* (The emphasis here is the author's).

"In my personal experience, I have found that in order to get properly fitting trusses, it is necessary for me to fit them myself and not rely upon the ordinary surgical supply house, where they are fitted in a haphazard manner and without a special knowledge of anatomy. I have found that without a properly fitting truss, one that does not at all times maintain sufficient pressure to get the walls of the canal in apposition, the injection treatment is not satisfactory. On the other hand, where trusses have been satisfactorily applied, then proliferation tends to accomplish everything that a surgical procedure would do, and in a more satisfactory manner. The method, however, requires a great deal of time and attention, probably more than the ordinary surgeon in active practice would be willing to give to it."

ONE of the criticisms made is that this method is a blind one. In refutation of this it can be said that there is no difficulty in palpating the rings by invagination of the scrotum. Also the injections are made at both of the rings and along the canal. Histological studies have proved that injections at the external ring are carried by lymphatic drainage up along the canal toward the internal ring. Most of the objections put forth against this form of treatment have been made by surgeons who have not tried this method at all or who have not given it careful study before trial.

This ambulatory method of injection treatments does not apply to all forms of hernias. Before this method can be used a careful examination of the patient must be made. Coughing, severe cardiac involvements, ascites, and many other similar, generally debilitating conditions are contra-indications. Locally the hernia itself must be reducible. Irreducibility and sliding hernias are also contra-indications to this method of treatment.

The records of the men of the type of Drs. Rice, Bratrud, Mayer, McQuillan, and many others, including the author, show that the injection treatment gives a very good result in cases where recurrences have occurred after surgical treatments have been given.

The recurrences from the injection treatment vary from 2% to 9% according to various reports. As a matter of fact, recurrence is a poor title for these cases. They should be classified rather as under-treatment, because these cases are remedied by a few extra injections as soon as it is noticed that the proliferative process has been insufficient. Therefore, even if the percentage of surgical recurrences were smaller, the fact that a new operation and subsequent incapacitation is avoided should be one of the most important factors in favor of this injection method.

In conclusion may I quote Dr. L. J. McQuillan, of Chicago, who says:

"Needless to say this method is in its infancy,

but, if the medical profession will accept it and use it in the manner and the place for which it is intended, it will add another method in their armamentarium to combat a serious problem with which the public at large is afflicted and with which the large employers of labor are constantly confronted."

Occupational Diseases

—and the General Practice of Medicine—

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RECENTLY it was my privilege to undertake an interesting piece of historical research, to collect and compile data for a book on the *"History of Occupational Diseases"* which is now being serially published in your official journal, INDUSTRIAL MEDICINE. It gave me a splendid opportunity to make certain deductions as to the future trend of occupational diseases and their importance in the cause of degenerative changes which increase mortality and lessen the span of life in the industrial employed.*

One is impressed by the limited knowledge and the lesser known facts about the common occupational diseases which are the results of physical and chemical agents. The tremendous advancement in knowledge of physical and snythetic chemistry during the last 20 years has developed useful discoveries which have brought about social and industrial changes almost revolutionary, and have produced a train of industrial and domestic hazards of corresponding significance. Every new process, improvement or discovery presents some new danger; so much so that today occupational hazards exist in from four out of five trades. To complicate matters, composite industrial toxic chemicals, as pointed out by Buergi, may have variable effects on the worker; two substances may mix to yield a new chemical body, they may modify each other, the penetrability of the cell membranes may be affected or made less absorptive. Because of the increasing number of chemicals being used in industry and in the home and farm, and the increased morbidity due to toxic substances which often are factors in the cause of chronic degenerative diseases not properly diagnosed, it behooves both the industrial physician and the general medical profession to be continually observant in order that they may be equipped for a better understanding of occupational diseases, of toxicology and of the physiological and pathological changes encountered.

In the field of public health—and for that matter in the general practice of curative medicine—consideration of the chief causative agent of disease has been centered on bacterial origin. It has been from this basis that modern medicine and public health have developed.

When you consider this great industrial country of ours, in which practically 50 millions of workers are gainfully engaged, it becomes clear that medical and public health professions must take more interest in occupational diseases. One has only to consult a general textbook on medicine to find that it contains descriptions of not more than about 10 occupational diseases.

The industrial physician of the past was held in scorn by the general profession and was looked upon as a contract doctor or first aid man. The evolution of industrial medicine progressed notwithstanding this absurd stigma, and today it provides a most dignified and respected field for scientific medical practice. Moreover, many of our present occupational diseases were recognized through the observations and experiences of our early plant physicians and surgeons who recognized that certain maladies were the direct results of industrial environment and not due to infectious organisms. The ever increasing incidence of industrial illnesses and accidents stimulated investigation and study of the various hazards for the purpose of determining the causes and controlling methods for their prevention. The whole organization of industrial hygiene was developed along with the great expansion of mechanical industry.

Standards of medical education in American schools likewise have progressed during this last quarter of the century. They develop medical men, better trained in the basic sciences, who, when they enter these fields of industrial medicine or hygiene, possess a keener insight for the pursuit of investigation. It remains to be seen what the next decade will produce in view of the tremendous interest that the medical profession is now taking in these diseases. Undoubtedly many of the problems presented by the now unknown or unrecognized elements will be recognized and solved. These will suggest better methods for the prevention of hazards by safety measures, and will make possible the recognition of early symptoms before grave pathology develops.

What safety is to preventable surgery in industry, industrial hygiene is to occupational diseases. The prevention of industrial accidents is being accomplished and the pathology of traumatic acute surgery is simple and well understood. However, this is not true of occupational diseases usually, because of their chronicity, longer periods of exposure, insufficient evidence and complicated factors that exist due to the lack of information regarding the toxic action of industrial poisons. Because of this lack of knowledge, future progress and success will depend on such basic medical sciences as pathology, physiology, toxicology and biochemistry.

Every commonwealth in the Union should have in the state department of health, a bureau of industrial hygiene, with well trained personnel for laboratory and field investigations. Such a bureau will aid the industrialist and the general medical profession in promoting the recognition of the causes of disease due to physical and chemical agents. It will also conduct research in industrial toxicology, evolve standards in problems in engineering and in hygienic control and prophylaxis. Our knowledge and research would be materially advanced if all persons dying from occupational diseases could be autopsied for medicolegal purposes, compensation benefits and especially for the better understanding of pathological changes involved. Such a procedure is made possible through the splendid progress in the present knowledge of silicosis and industrial tuberculosis at the Medical Institute at the Rand in South Africa.

* Presented at the Midwest Conference on Occupational Diseases, Detroit, May 5, 1937.

Our government and our Universities in their large research laboratories must endeavor to develop simple instruments to make tests of the many common toxic hazards responsible for occupational morbidity. These simple tests would aid in estimating and detecting readily dusts, toxic metals, vapors and solvents, so that any practitioner or trained assistant could utilize them for routine use.

This is the day in which the socialization of medicine is much discussed among the general medical profession. The industrial world recognizes that the modern well trained industrial physician as well as the part time factory doctor, has a definite place in this form of practice that provides for both curative and preventive medicine. The plant physician in either full or part time service, should make a complete physical examination with the necessary laboratory tests at the time the applicant is employed. To make a complete record of such findings, especially the past history of the case, is of great importance, e.g., in the dusty trades and in industrial tuberculosis, and for the placement of men on jobs.

The second duty of the physician is to study and to itemize every possible plant hazard that may be harmful, or that may produce discomfort to the workers. This will include all the toxic substances that are used in the various processes and the physical agents that are contacted.

With a small plant dispensary at which the employees may receive service at stated times, the physician has the opportunity of observing and recording the earliest signs or defects that may affect a worker. Often a worker will be found to have contact with certain hazards. The collecting and integrating of such signs constitute a real contribution to scientific medicine and afford also numerous opportunities for the prevention of morbidity, and for the installation of protective measures to counteract exposures. Many of the incipient symptoms may be the same common ones that are found in general medical practice, such as headache, vertigo, gastro-intestinal upsets, weakness, cough, muscular pains, skin irritations, etc.

Again must be pointed out the necessity of determining the deviations from the normal. The recognition of early incipient changes before morbidity takes place is most valuable, not only for curative procedure, but as an index in discovering and determining physiologically the permissible amount of a potential hazard that may be considered reasonably safe to maintain.

The factory physician in endeavoring to improve the comfort and health of the employees so as to receive the maximum efficiency returns, must endeavor to improve always his physiological understanding of man. If, as actuaries inform us, the span of life is less and the incidence of organic degenerative diseases higher in the industrially employed, there is a big task ahead for the medical and engineering profession, to determine by practical research the minimum working conditions necessary for the employee to perform his job within his normal capacity. In addition to the accidents and occupational diseases to be considered, are the environmental conditions such as fatigue, strain, noise, monotony, jarring, illumination, etc., all warranting scientific consideration.

At the end of the seventeenth century, the immortal Ramazzinni, father of industrial medcine, was first to realize the importance of the causative connection in occupation and disease. It was his practice to ask every patient, "What is your occupation?" He states that the medical man even when aware of the patient's profession, seldom accredits sufficient importance to it. To illustrate a case; a man, ill for three weeks with jaundice, claimed he had been prospecting for the past month. After 10 days in a hospital where he was thoroughly examined and given every available test, the cause of his jaundice was unknown. He was obliged to leave the hospital for financial reasons, to go home, and to close out his business. It was then learned that he was a dry cleaner; immediately the diagnosis of carbon tetrachloride poisoning was clear.

IN THE general practice of medicine we physicians must not be misled into believing that the toxic hazards which are responsible for many of the occupational diseases are primarily confined to industry. The chemical age has ventured into warfare, into agriculture, and into our own domestic lives. The present day practitioner should bear in mind that the definite cause of much disease is some toxic chemical. We cannot help observing the ever increasing morbidity and mortality rates in our homes, due too often to modern physical and chemical agents such as carbon monoxide gas from heating apparatus, to exhausts from automobiles; the solvents, polishes, and cleaning compounds; the paints, insecticides, disinfectants; electric shock, etc., the same deadly agents as are daily encountered in industry. More and more is the physician obliged to know the effect that these toxic agents have on the incidence of morbidity. Take for instance a quick drying enamel containing benzol, so popular today for beautifying kitchen and bathroom furniture. A housewife using such a product may develop a type of weakness like that which follows influenza, but without any cough or other signs—a puzzling case. A routine blood count if made discloses a low leucopenia, a diagnosis is made of agranulocytosis, and the real agent, benzol, often is not suspected.

It is high time for the medical profession to think in terms of occupational disease etiology in the consideration of every obscure case not due to an infectious process. It is also time for the profession to be able to interpret the nature of phenomena in the worker who possesses a history of contact with any chemical hazard, especially since these cases are found in the home and on the farm as often now as in industry. In the general practice of medicine in our rural communities, especially in the horticultural districts, conditions similar to those of industry are encountered and many perplexing problems confront the physicians, for instance, the toxic agents that are used as disinfectants and insecticides for spraying trees and garden plants must be discovered and considered. Our agricultural experiment stations, in the endeavor to destroy scales, insects, worms, *et al.*, are continually developing the use of newer rare elements, as thallium and selenium. These researches are of interest to general medical practitioners, for they reveal important causative factors as well as impressing one with the wonders and dangers of chemistry. Selenium, for example, is a successful spray in the

destruction of the red spider, yet it is most dangerous to cover crops of certain forage and table plants which take this element from the soil, for death to animals and morbidity to man may result.

There is the arsenate of lead spray that is fatal to the coddling moth, but here again cases of both lead and arsenic poisoning or definite resulting dermatitis have been reported among farmers. Fluorides have been used successfully for biting insects; now in some communities it is being banned on account of the dangerous effect in mottling the teeth of human beings. It has been demonstrated that methyl bromide is effective in the destruction of boring insects. These creatures die as a result of a delayed toxic action in the respiratory tube, similar to nitrous fumes producing edema of the lungs in workmen. An interesting point worth noting is that the use of methyl bromide as a rodenticide proved unsuccessful, but it destroyed the flea. This discovery should be made available for public health measures in plague control. In history we are familiar with the arsenic eaters and how they built up a tolerance for this deadly poison. This process, probably going on among industrial workers every day, does not receive the attention it deserves. It may be that certain early degenerative changes attributable to other causes are due to this one alone. In California the citriculturists have for years been using cyanide gas successfully for a certain destructive scale. Now it is found that the scale has evolved to a vigorous strain by virtually developing a "gas mask" tolerance for the lethal agent. May we not presuppose, if the agricultural scientist has noted by using arsenate of lead spray in an orange grove that the resulting fruit becomes insipid, the lesson derived would encourage that eternal vigilance in interpreting the possibilities of physiological changes that may take place among workers with such elements.

IN INDUSTRY at the present time, the greatest hazard attracting our attention is the increased use of solvents and the halogen derivatives of hydrocarbons of low specific gravity which are definitely toxic. The collective knowledge we have at present, as to how these poisonous agents act upon certain cells when inspired, the pathological changes that take place in different organs, and the signs and symptoms that are significant in comprehending for a diagnosis, is far from conclusive. It should be an axiom, as Zangger, of Zurich, pointed out, that all solvents are toxic, depending on amount of exposure and concentration. Some volatile solvents have an effect on some special organs such as turpentine, producing nephritis; carbon bisulphide, sterility; methyl alcohol, blindness; benzol, menorrhagia; and carbon tetrachloride, toxic jaundice.

Physicians must recognize that jaundice cases are very likely to be due to toxic solvents, metals or gases, such as benzol, carbon tetrachloride, chloroform, arsenic, phosphorous, etc. In practice we are already familiar with toxic jaundice and acute yellow atrophy of the liver following administrations of salvarsan, and with the use of chloroform anesthesia in obstetrics.

The pathological manifestations due to radium, radioactive substances and x-rays, with the resulting incapacity among scientists and medical men, continue to present a serious occupational hazard. At the University of California radiation laboratory recently, in the researches in "splitting the atom" the resulting neutrons were found to be radioactive and from five to 10 times more lethal than x-ray. The decreased leucocyte count examination revealed definite changes to the organism.

It is definitely estimated that some 15 million persons in the United States are employed in the manufacturing, chemical and mineral industries. Among the general illnesses afflicting these workers, tuberculosis, pneumonia, and degenerative diseases are preponderant. About a half million alone are exposed in the dusty trades in which silica is a definite hazard and the tubercular incidence is also high. In the granite worker, the mortality rate per annum is 3.7 per 100.

As the incidence of tuberculosis decreased in the general mortality rates during the last 30 years, the industrial tuberculosis mortality curve rose and continued high. The conquest of tuberculosis in industry will be possible when occupational tuberculosis becomes a reportable compensable disease, and when industrial medical practice becomes more perfected and socialized.

Outstanding occupational diseases such as lead, silicosis and carbon monoxide have been scientifically studied, the various signs perfected, accurate simple tests for their detection made, and measures for the prevention and therapy based on sound physiological research formed. The future will develop likewise the same definite knowledge of many of the industrial diseases which at present are not completely understood. Furthermore, medical science and industrial hygiene will insist that chemistry, through research, outlaw many toxic agents now in use, and bring forth substitutes more hygienic for mankind.

Every industrial hygienist will welcome the day when all the States enact laws for occupational disease disability. The motive of such a law is not primarily for compensation, but, more important, for the securing of exact information as to the cause and effect of industrial diseases. Such information will insure experts in analysing and integrating the physical effects on the worker, in establishing criteria as to minimum environmental exposures, and in promoting control and preventive measures.

Our county medical societies from time to time should hold symposiums on the common occupational diseases and hazards, with demonstrations of simple tests for the prevention and identification of the causative factors and of the newer methods for treatments developed by our research laboratories and our industrial physicians.

The general practitioners owe to their patients and to the medical profession a specific duty—that of making a searching inquiry as to the causative agents in all cases of dermatological manifestations, and especially to epitheliomatous growths. Again the first question is presented: What is your occupation? What chemicals and irritants are used in the processes? Then the search for the known substances that possess carcinogenic properties is in order.

TO CONCLUDE—the contributions in this paper have been made in order to stimulate the interest

of the general practitioner in medicine in a plan for the furtherance of discovery, diagnosis, and treatment of all occupational diseases, including some of the same types of maladies that are found in the modern home and farm; to promote safety measures for the prevention of the same; to develop and perfect simple tests for diagnosis and detection; to encourage a state laboratory of occupational hygiene in each commonwealth; to insist on reporting of occupational diseases; and to legalize autopsies on persons dying from such diseases. The general practice of medicine will then add more laurels to its illustrious achievements, and by lessening the incidence of occupational and degenerative diseases, will become an even greater benefactor to mankind.

Pulmonary Embolism

Following Fracture of the Long Bones of the Lower Extremity —With a Case Report—

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PULMONARY embolism, commonly known as pulmonary apoplexy or pulmonary infarction, no doubt occurs much more frequently following fractures of the long bones of the lower extremity than is generally thought.*

An embolus, following either a simple or a compound fracture, usually originates from the blood clot which forms at the site of, and as a result of, the injury. However, an embolus frequently originates from a clot formed within the walls of a traumatized vein, or from a bit of fat, which arises from the injured bone marrow, and gains entrance into the lumen of the vein.

Regardless of origin, the embolus enters the systemic venous circulation, and after its journey through the right side of the heart, passes by way of the pulmonary artery to the lung, where it may find lodgement, either in the pulmonary artery proper, or in one of its many ramifications. The final resting place of the embolus partially determines the amount of damage it produces.

A clot, or a bit of fat, blocking the pulmonary artery proper, or one of its main branches, is termed a massive occluding embolus, and is, in most cases, followed by instant death, while a small occluding embolus blocks one of the smaller branches and is usually, though not always, followed by infarction. When blockage of one of these terminal branches of the pulmonary artery fails to result in infarction, it is because the lung is also supplied by the bronchial arteries, and the capillary network in the lung tissue is so abundant, sufficient circulation is maintained, and the embolus is absorbed. It is this fact that leads us to believe that a previously disturbed pulmonary circulation predisposes to infarction following an embolus.

When many of the small branches of the pulmonary artery are blocked, as is usually the case with fat emboli, we speak of the condition as a "shower of emboli," and multiple infarcts may result.

Since a massive occluding embolus is usually followed by instant death, its discussion is entirely beyond the scope of this paper. Let it suffice to say that Trendelenburg devised an operation for this type of embolus, and Kirschner so perfected the technique, that, up to 1931, he had been able to save seven patients who suffered from blockage of one of the larger branches of the pulmonary artery.

Following fracture, the small occluding type of embolus usually occurs three to five weeks after injury. At the onset, before the formation of the lung infarct, there are few physical signs upon which to base a diagnosis. The patient, previously considered to be recovering nicely from the original injury, will complain of sudden, sharp, stabbing pains in the affected side of the thorax, usually over the lower lobe of the lung, since it is the lower lobe that is most often involved. The respiration will be shallow and difficult, and the temperature may, or may not be, as high as 100°F. The pulse is rapid at this stage, and the patient may be slightly cyanotic.

Usually within 12 to 16 hours, infarction has progressed sufficiently so that the physical signs will be more pronounced. There is usually marked dyspnea and cyanosis, the pulse rate has increased, and the temperature may be as high as 102°F.

There is usually an area of percussion dullness over the affected site, and there is decreased expansion of the involved lung. There may or may not be a few fine rales present in the normal lung tissue adjacent to the infarct.

Infarcts are usually wedge-shaped with the base of the wedge toward the surface of the lung, and chiefly at the periphery, and therefore, the pleura, over the base of the infarct, becomes inflamed, producing a friction rub, which is the most constant sign of pulmonary embolism. Cough and hemoptysis are usually present, blood being effused into the air cells and interstitial tissue, and later coughed up.

Breath sounds are frequently absent or diminished, but if the infarct is small, no change in breath sounds will be noted.

If a roentgenogram is taken, after infarct formation, the shadow of the affected area may or may not be seen. If seen, it is less dense but sharper in outline than the shadow of consolidation due to pneumonia. Frequently the affected area is so small that no shadow is cast, so that, while x-ray may be of diagnostic value in some cases, it is seldom convincing.

Other laboratory procedures aid only in making a differential diagnosis.

Prognosis depends upon the nature of the embolus or emboli as well as the size of the resulting infarcts. If the embolus is infected, abscess formation will most likely result or, as with a shower of emboli, multiple abscesses. In either event, the mortality rate is increased, but with the small occluding, non-infected, type of embolus, the prognosis is fair, there being a 15 to 20% mortality.

After a variable length of time, depending upon size, the infarct becomes decolorized by diffusion of dissolved hemoglobin, inflammatory changes occur in its periplery, the blood-cells and involved tissue may undergo degeneration and be absorbed, and finally the original area of infarction may be replaced by pigmented scar tissue. As this process of absorption progresses, the physical findings dis-

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appear, one by one, until dullness to percussion is the one remaining sign. This dullness is due to replacement of air containing tissue by fibrous scar tissue, and to thickening of the pleura, and may persist permanently.

From what has been said, it will be noted that the symptoms and physical signs of a non-infected, small occluding pulmonary embolus followed by infarction are not pathognomonic, but are often misleading. Due to the similarity of physical signs, together with the failure to make a thorough physical examination, the condition is frequently diagnosed as lobar pneumonia, intercostal neuralgia, acute pleurisy and rarely gastric hemorrhage.

THE differential diagnosis is not particularly difficult; the temperature and the leucocytosis are never so high as in a typical case of lobar pneumonia; the characteristic rales, so often heard in early lobar pneumonia, are usually absent; the cough is not as distressing, and the roentgenogram, as previously mentioned, may aid in distinguishing between infarction and lobar pneumonia. In intercostal neuralgia, none of the auscultory signs of infarction are present, nor is there any dullness to percussion. Acute pleurisy is often ushered in by a chill; the temperature may be as high as 103° F; the immobility of the affected side is usually not as great as with infarction, vocal fremitus is usually absent, and the intercostal spaces may be obliterated if the effusion is large. The percussion dullness obtained over the effusion of acute pleurisy is of a peculiar woody character, and the breath sounds are sometimes audible but are tubular in quality. Leucocytosis in acute pleurisy ranges from 10,000 to 15,000 and, if a roentgenogram is made, the diagnosis is always certain. The frothy blood with alkaline reaction should readily differentiate pulmonary infarction from gastric hemorrhage with its dark blood of acid reaction. A history of recent injury to the lower extremity may also aid in making a differential diagnosis.

As soon as pulmonary embolism is suspected, the patient should be put to bed and, in spite of the cyanosis, morphine should be given repeatedly to keep the patient quiet. The patient should not be turned or moved. The morphine will usually control the pain, but may well be supplemented by a mustard plaster to the affected side. If cough is distressing, a sedative cough mixture should be given. The bowels should be kept open with a mild laxative, but purging is counter-indicated. Preventive treatment, following fracture, consists of gentle handling and manipulation of the part and the avoiding of early massage, either of which may detach blood clots from their point of origin.

Usually in from two to three weeks, depending on the size of the resulting infarct, the friction rub disappears, pain ceases, blood disappears from the sputum and the breath sounds become normal. The patient should not be allowed out of bed until the subsidence of physical signs and symptoms indicates that absorption of the infarct has been completed. Emboli following fracture seldom recur.

An interesting case recently coming under my observation, was that of a negro, male, railway employee, age 42, who had a simple transverse fracture of the middle third of the right tibia. A cast had already been applied in the small town where the accident causing the injury occurred, after which the patient was transported a distance of about 25 miles to Atlanta. A roentgenogram was made within 48 hours of the time of injury and the fragments of the tibia were seen to be in perfect position, so after a few minor adjustments, such as trimming and padding of the cast, the patient was sent home and instructed to remain in bed for several days.

After one week, the patient was given crutches, and allowed out of bed. No complications had arisen, so visits were now limited to once or twice a week. Twenty-one days after receipt of injury the patient sent me word that something had suddenly happened to him and he was not doing well. Shortly after receiving the message I arrived at the patient's home, to find him sitting up in a chair, having some difficulty in breathing. There was a frightened expression on his face, temperature was normal, and the pulse rate 100. He stated that a sharp pain had suddenly struck him in the right side of his chest, and was so severe in nature that he could hardly breathe.

Percussion and auscultation of chest were negative. The patient was put to bed, given morphine, gr. ¼, and a mustard plaster placed over the site of pain. He was also given a saline laxative and placed on a soft diet.

The following morning his temperature was 99.3° F., breathing still somewhat labored, pulse was rapid and weak and he still complained of intense pain in the lower part of the right half of the thorax. Pain was aggravated by deep breathing.

Percussion revealed slight dullness in an area about three inches in diameter at the right lung base and a friction rub was now quite audible. A blood count was made at this time, but proved to be within normal limits.

A diagnosis of pulmonary embolus with infarction was made, and it was deemed inadvisable to move the patient to a hospital, so a special nurse was obtained and instructed to keep him absolutely quiet by administration of morphine every two to three hours if necessary. Due to lack of facilities no x-ray was made. By the next day the patient had developed a cough and streaks of bright red frothy blood were noticed in the sputum. There were no essential changes in the other findings, except that no breath sounds could be heard over the area of percussion dullness.

Besides the administration of morphine, the treatment mentioned previously was instituted. Under such treatment, the blood disappeared from the sputum, and pain subsided in about 10 days, but the other findings remained unchanged until the fifteenth day. At this time no friction rub could be heard, but the dullness to percussion and the abscence of breath sounds still persisted.

The patient was kept in bed until all symptoms and signs had disappeared except the dullness to percussion, which at the present time is still quite evident.

After three weeks in bed the patient was allowed to be up, and the cast was removed from the leg and a posterior splint was applied. The posterior splint was removed after two weeks and x-ray revealed good union, between the fragments.

The Atmospheric Content of Lead

—And Its Correlation with Basophilic Aggregation Tests in Exposed Storage Battery Workers—

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SINCE the last published report[1] made by these workers on the use of the basophilic aggregation test as a measure of lead absorption and early lead poisoning, the number of tests made under our control has increased to approximately 24,500.

As the use of this method extends, it inevitably becomes desirable to seek out the nature and extent of correlations that may be established between the findings from this test and those from urinary and fecal analyses, atmospheric concentrations of lead, clinical manifestations and other blood changes such as are frequently carried out in relation to examinations for lead absorption and lead poisoning. Already some investigative work has been carried out for the purposes of determining the extent of these correlations, but only under conditions that preclude disclosure. Lately, a limited inquiry has been directed to lead exposures in a series of small scale storage battery plants. The results, while not elaborate, unfailingly indicate the association of high basophilic percentages in workers exposed to high concentrations of atmospheric lead. These results, together with pertinent comment, have led to this report.

The Use of Lead in the Storage Battery Industry

IT IS not the design of this minor publication to describe in detail the various steps in storage battery manufacture, potentially and often practically leading to lead exposures. Adequate descriptions may be found in publications by Hamilton,[2] Wigdortschik and Kupritz,[3,4] Balsac, Lafont and Feil,[5] Wells,[6] Greenburg, Schaye and Shlionsky,[7] Russell, Jones, Bloomfield and others.[9]

In general it may be noted that the chief operations are the mixing of lead oxides preparatory to grid pasting, pasting of mixed lead oxides into grid plates, casting of lead grids, plate forming, lead burning, battery assembly, lead salvaging, and miscellaneous janitor and clean-up work. In a few plants, lead oxides are produced on the premises, but only in the very largest of establishments. Ordinarily, chief exposures grow out of the manipulation of the dry lead oxides, the preparation of grid paste, the application of paste to lead grids, the cleaning and inspection of plates prior to forming. In addition, practical exposures frequently grow out of lead reclamation and janitor services.

As a general rule, freedom from exposures to lead in this industry is in proportion to the size of the manufacturing plant. Large establishments, almost without exception, have introduced protective devices, automatic features and other safeguards to the point that clinical lead poisoning is a rarity. Conversely, in every city a few petty battery manufacturing plants are likely to exist, operating in two or three rooms under conditions obviously exposing all workmen. In the aggregate, these plants produce definitely more clinical lead poisoning than arise out of employment in larger plants. This paper is based upon a survey of minor manufacturing plants in one city where the total number of employees in any one plant rarely exceeds 10.

Conditions of Work in the Usual Petty Plant

AT ONCE it is necessary to draw a distinction between those plants that merely assemble battery parts and those other plants which carry out substantially all operations necessary in battery manufacture. Without exception, work conditions in the assembly plants are far superior to those in the manufacturing plants, and on the whole, these assembly plants are not highly culpable with respect to producing lead exposures.

In the city concerned in this investigation, it was found that as little as $400 would purchase sufficient equipment to carry out storage battery manufacture and that an additional $200 would purchase raw materials sufficient to start operations. These plants customarily operate under conditions without any adequate exhaust or ventilating systems and without any machinery for the enclosed mixing of lead oxides into paste—instead the mixing may be carried out in open devices such as tubs or barrels. Without exception, no facilities, or inadequate facilities, were found for bathing, consumption of food, change of garments, etc. In the 13 battery plants investigated, more than half make use of no more than two workers. In many of these plants, it is found that no two manufacturing processes are carried out at any one time; starting with the unmixed dry lead oxides, operations are carried out step by step to the point of the completion of the battery, ready for sale. Activities in these plants not only are highly seasonal, but ordinarily are highly intermittent. Several plants operate not more than five days in any one month. During this period, sufficient batteries may be produced to tax the selling capacity of the organization concerned. These factors tend to mitigate the probability of lead poisoning, but even so, on a proportional basis, this industry and this type of the industry, produces more clinical lead poisoning than any other industry in this city. Employment ordinarily is so distasteful that workers rarely remain for more than one or two months, and the cessation of employment is often brought about by the actuality of lead poisoning, for which there is no required compensation in this State. Often circumstances are such that no monetary responsibility may be imposed upon these small employers. This work is classified by some workers as a "last chance" job, in which the labor turnover is enormously high, due to the occurrence of the almost inevitable lead poisoning or to the procurement of more desirable work. Other plants in entirely dissimilar industries frequently inherit clinical lead poisoning in the absence of exposures in their own plants, but arising in workers who have been able to abandon

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employment in low types of storage battery factories.

In making the study of this stratum of the storage battery industry, the work was divided into three parts, as follows:

1. An engineering survey of each plant was first conducted to establish familiarity with the various manufacturing processes.

2. Collection of air samples and the determination of the concentration of lead at the various manufacturing operations in each plant. Other samples were collected to indicate the general workroom atmospheric content of lead.

3. Blood specimens were secured from all employees working at the time the plants were visited. From these specimens, basophilic aggregation cell counts were made. Two or three weeks elapsed between collecting air samples and making the basophilic aggregation tests. This delay in the making of basophilic aggregation tests was through design, inasmuch as there is a known lag with respect to the time of exposure prior to the appearance of increased numbers of basophilic aggregations. This lag ranges from one to three weeks.

Health Hazards and the Various Operations

ALTHOUGH it is our belief that exposures connected with the various manufacturing processes differ greatly, it is difficult to demarcate these exposures because all operations are usually carried out in the same work room. In other words, it is believed that the mixing operation might contaminate the air of the whole workroom with lead, and greatly affect the lead findings around the burning table, which may be only a few feet from the mixer.

No less, the individual manufacturing operations briefly are appraised with regard to their health hazards.

1. MELTING AND CASTING:

The melting and casting operations will be considered as one because of their close relation. In all cases, the operator stands close to the melting furnace and does casting. In those plants which are using unhooded furnaces (this is usually the case) the operator is exposed to lead fume arising from the molten lead. The extent of this lead fume depends upon the temperature of the molten lead. The higher the temperature is, the greater the quantity of lead being expelled into the air. In no case were these lead pots controlled with thermostats and as a result the temperature of the molten lead was much higher than necessary. In this survey, this fact greatly affected the lead exposure connected with lead melting and casting.

2. MIXING:

It is our opinion that the greatest hazard connected with the storage battery industry, as conducted on a petty scale, accompanies the mixing operation. Large quantities of lead oxide dust are usually expelled into the air, both in transferring the oxides to the mixer and when the mixer is first started. Because of the small particle size of these dusts, they are suspended in the air and gradually float to all parts of the work room. Although this operation is carried out only for short periods of time each day, sufficient lead oxide may be expelled to cause serious exposure throughout the work day.

3. PASTING:

The lead oxides as handled by the paster are in the form of a paste and as such are of little significance, except if taken into the body through the mouth while smoking or other similar procedures. However, it is usually found that the pasting tables are littered with dry lead oxides and dusts are easily thrust into the air while the paster is working. This may be caused by dropping of tools or otherwise fanning the dry dusts in carrying out his regular work. Because of the close proximity in most cases, of the mixer and pasting table, the exposure at these two positions is found to be about the same.

4. BURNING:

The exposure connected with the lead burning operations is probably the least hazardous of all the manufacturing operations, except assembly and forming and charging, because of the short period of time the operator is actually burning lead. Approximately 75% of the operator's time is spent in placing of plates and posts on the rack. This does not mean that he is not exposed to lead at all times, however, because he frequently stirs up lead oxide dusts which accumulate on the table.

5. ASSEMBLING:

The dust exposure accompanying the assembling operation is not great, as the only lead oxide handled is in the form of dry pasted plates. Proximity to other and more dangerous activities represents the outstanding source of injury.

6. FORMING AND CHARGING:

Providing these operations are confined, the worker will not be exposed to lead.

Experimental

THE apparatus used for collecting air samples for lead determinations was a modified, Greenburg-Smith impinger apparatus.[8] The apparatus consists of a rotor pump which is equipped with a standard orifice and measuring devices for metering the air. The pump was connected to an impinger tube and the lead collected in the water. These samples were obtained as near as possible to operators' positions and at all manufacturing operations. In general, air samples were taken over a period of 20 minutes at the rate of one cubic foot per minute.

After the samples were collected, they were treated according to the method of Harrold, Meek and Holden,[10] and the lead determined. Calculations were then made to convert the amount of lead in the sample to milligrams per 10 cubic meters of air at standard conditions.

In addition to making lead determinations, basophilic aggregation cell counts were made of all workers. The blood of healthy human adults rarely contains more than 1.0% to 2.0% of basophilic cells. The percentage of basophilic cells for those workers absorbing lead without clinical manifestations is usually 2 to 4, while in some cases the counts may be as high as 15%. Findings of 2% or greater at once suggest lead absorption.

Table 1 is a combined table, showing the results of lead determinations and the basophilic aggregation counts.

Comment on Experimental Study

OF THE entire number of controls, it is to be noted that not one person yields a basophilic aggregation percentage in excess of 1.7%. As

many times pointed out, this is characteristic of the healthy, unexposed adult. On the other hand, of the total number of battery workers, including those persons performing only clerical services, 44% presented basophilic aggregations in excess of 2% of the total number of red blood cells. While this percentage may seem high, it is to be emphasized that the conditions of work in most places were favorable to universal lead poisoning. The lack of proof of universal lead absorption or lead poisoning probably is due only to the intermittency of work, not only on a seasonal basis, but on a month by month basis as well.

While no physical examinations were carried out, it is known that several of the persons here classified as showing lead absorption were instances of early lead poisoning of clinical type, which impression was formed from casual inspection and from offhand remarks made by workers in the course of survey activities.

While these basophilic aggregation tests numerically represent only a small fraction of the near 25,000 that have been conducted, they are regarded as possessing significance in that they were made on workers exposed to high atmospheric concentrations of lead in a combined form.

Table 1. Atmospheric Lead Determinations and Corresponding B. A. Counts

Plant	Position	Lead per 10 cubic meters of air (in mgms.)	Worker	B. A. Cell Count (percentage)
No. 1	Pasting	6.4	Paster's Helper	6.6
	Mixing	248.0	Paster	3.0
	Racking	3.9	Melter and Caster	10.0
	Melting and Casting	7.7	Melter and Caster	5.0
	Lead Burning	23.6	Lead Burner	2.3
	Blank	00.0	Lead Burner	1.4
			Assembler	4.1
			Manager	1.5
			Office Worker	1.1
No. 2	Pasting	8.1	Office Worker	1.9
	Mixing	6.8	Office Worker	1.3
	Melting	12.0	Office-Plant Worker	1.1
	Blank	00.0	Deliverer	0.9
			Paster	4.0
No. 3	Pasting	1.8	Manager	1.0
	Mixing	2.3	Baby	0.6
	Melting	4.9		
	Melting	2.7		
	Blank	0.0		
No. 4	Burning	0.55	Burner	1.1
	Burning	2.00	Burner Helper	1.0
	Blank	0.00	Foreman	0.7
			Fireman	0.9
			Charger	1.4
			Manager	0.8
			Repairer	1.5
			Shipper	1.3
			Assembler	1.2
			Former and Charger	1.4
No. 5	Pasting	3.1	Paster	10.2
	Mixing	23.0	Paster	5.2
	Melting	2.8	Helper	3.0
	Workroom	0.53	Caster	7.7
	Blank	0.00	Assembler-Charger	8.5
			Paster	2.0
No. 6	Pasting	5.9	Assembler	4.0
	Pasting	7.8	Paster	6.5
	Mixing	16.7	Office Worker	1.0
	Workroom	5.6	Office-Plant Worker	2.0
	Blank	0.00	Office Worker	2.5
No. 7	Pasting	4.1	Paster	2.4
	Pasting	3.7		
	Melting	2.05		
	Workroom	2.23		
	Blank	0.00		
No. 8	Pasting	2.8	Wrecker	4.6
	Pasting	3.34	Foreman	3.3
	Pasting	2.60	Paster	9.8
	Mixing	1.22	Wrecker	5.8
	Mixing	7.10	Handy Helper	1.7
	Mixing	1.01	Rebuilder	1.7
	Burning	5.45	Wrecker	3.5
	Blank		Rebuilder	2.1
			Assembler	1.8
			Assembler	3.5
			Manager	1.1
			Wrecker	3.6
			Melter and Caster	4.1

In general, wherever a high concentration of lead was established in the atmosphere, this was accompanied by an increase above the usual of basophilic aggregations in the blood of exposed workers.

Comment

AS THE application of the basophilic aggregation test, as a measure of lead intake increases in extent and in value, it becomes highly desirable that this method come into no degree of disrepute because of deficiencies in technical procedure. From extensive correspondence that has grown up about this method, it becomes well established that some unfavorable results are related to demonstrable technical difficulties. A number of these are now mentioned:

1. In the preparation of the Manson stain, best results will be obtained if the boiling water to which the borax is added is allowed to cool to room temperature prior to the addition of the methylene blue. Otherwise, a precipitate may be formed in some instances.

2. The Manson stain is best used in covered jars, into which the slides to be stained are submerged. However, prior to the staining of any batch of slides, the surface of the stain should be skimmed off with a sheet of filter paper, in order to remove possible accumulations of precipitate, which sometimes forms at the surface.

3. From slides sent in for examination, it has been determined that the greater number present blood smears so thick as to make enumeration difficult and onerous. A single layer of discretely separated cells is desirable.

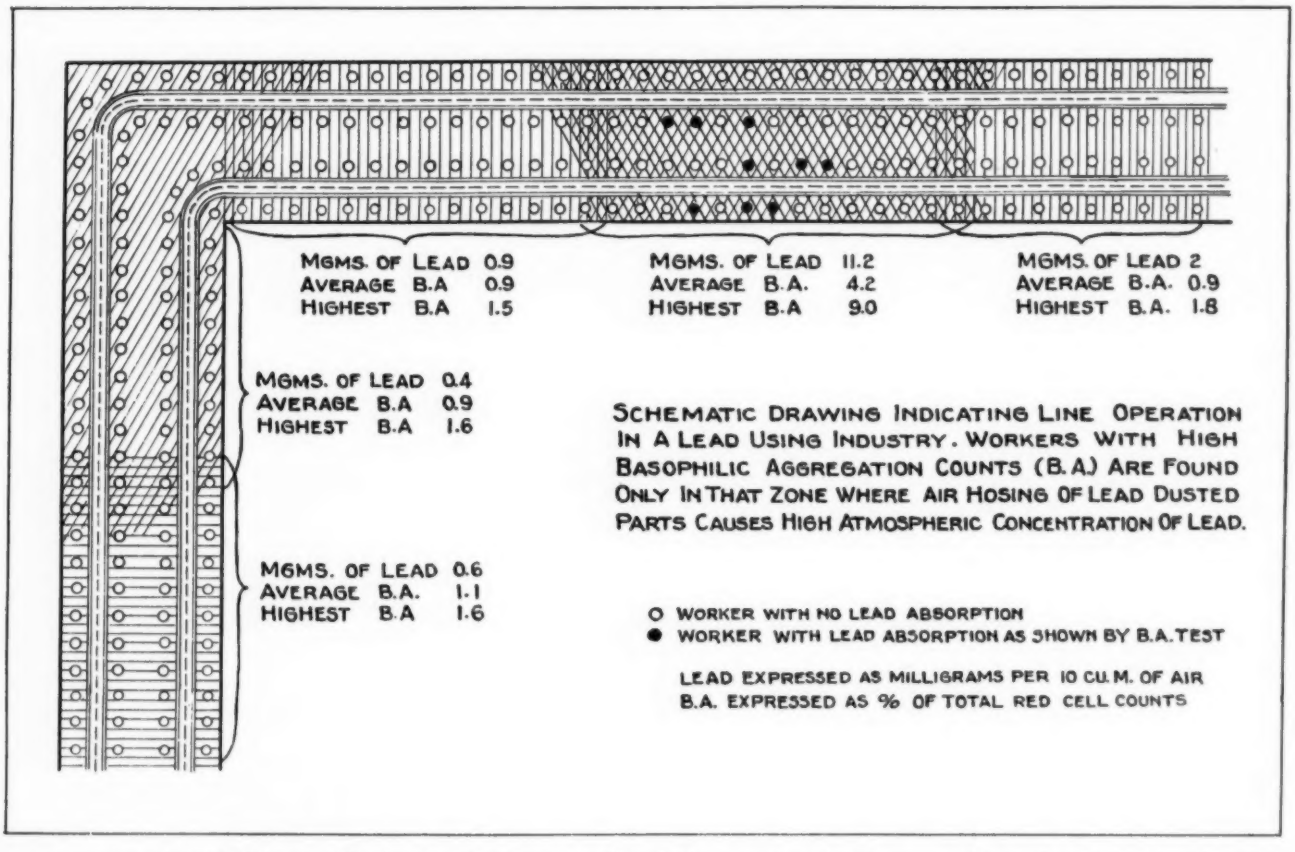
4. The use of xylol, alcohol or almost any other solvent commonly employed in the cleaning off of cedar oil leads to the removal from the slides of many basophilic aggregations, to the end that subsequently check counts may be unreliable.

5. Some batches of dry stain are inherently unsuited to this test because of chemical impurities which lead to unwanted and inaccurate results.

Some laboratories report in connection with instances of proved lead poisoning a percentage of basophilic aggregations in that zone regarded by us as within the usual limits for unexposed persons. Appropriate investigation of all circumstances usually establishes that as a result of some technical inaccuracy, the full number of basophilic aggregations potentially present are not being recognized as such and counted. In one instance, an industrial technician reported a 1.2% basophilic aggregation in a known case of early lead poisoning. A more experienced worker, making a count on the same slide, detected a percentage of 4.6 of basophilic aggregations, which is expectable.

No known reason exists for any recession from the statement that healthy persons, unexposed to lead or other sources of increased basophilic aggregation counts usually will not present percentages of basophilic aggregations in excess of 1.5, although very rarely apparently normal persons may present a percentage near 2. Such persons, on investigation, usually may be shown to exhibit an undue amount of oral sepsis, a tonsillar infection, sinus disease or some little apparent and comparatively unimportant condition.

One accompanying schematic drawing is designed to present the application of the basophilic aggregation test in spotting exposure points in lead using departments in industry. In the factory department leading to this drawing, all of the approximately four hundred workers employed were sent to the dispensary during the course of a two-day period for the purposes of


MGMS. OF LEAD 0.9
AVERAGE B.A 0.9
HIGHEST B.A 1.5
MGMS. OF LEAD 11.2
AVERAGE B.A. 4.2
HIGHEST B.A 9.0
MGMS. OF LEAD 2
AVERAGE B.A. 0.9
HIGHEST B.A. 1.8
MGMS. OF LEAD 0.4
AVERAGE B.A 0.9
HIGHEST B.A 1.6
MGMS. OF LEAD 0.6
AVERAGE B.A. 1.1
HIGHEST B.A 1.6
SCHEMATIC DRAWING INDICATING LINE OPERATION IN A LEAD USING INDUSTRY. WORKERS WITH HIGH BASOPHILIC AGGREGATION COUNTS (B.A) ARE FOUND ONLY IN THAT ZONE WHERE AIR HOSING OF LEAD DUSTED PARTS CAUSES HIGH ATMOSPHERIC CONCENTRATION OF LEAD.
O WORKER WITH NO LEAD ABSORPTION
● WORKER WITH LEAD ABSORPTION AS SHOWN BY B.A. TEST
LEAD EXPRESSED AS MILLIGRAMS PER 10 CU. M. OF AIR
B.A. EXPRESSED AS % OF TOTAL RED CELL COUNTS

supplying blood smears for basophilic aggregation examination. These workers were sent to the dispensary without any selection as to precise work points and no information was procured by the examiner as to types of employment—in fact no information was procured other than the name of the employee and his badge number. In due time, basophilic aggregation counts were made with the result that nine workmen presented counts well above the normal range. Then with the colored pin system, all workers were spotted on a blue print of the work department concerned. Through this maneuver, it was established that without exception the workers showing positive tests were employed at identical duties located in an area with a radius of about 30 feet. Then and then only quantitative determinations of lead in the atmosphere were made through the method described by Harrold, Meek and Holden[10], at this point and at other appropriate stations in the entire department. Only at this one location was the concentration of lead sufficiently high to have induced lead poisoning and to have provoked the high basophilic aggregation test encountered.

From this storage battery work or from any other investigations in which correlations have been sought between the quantity of lead in the atmosphere and the B. A. test, it may not be maintained that with any given increase in the atmospheric content of lead is there a corresponding and commensurate increase in the percentage of basophilic aggregations in the blood. It is unlikely that any such precise conformity ever may be demonstrated, since the content of lead in the atmosphere in most work places obviously varies from hour to hour and day to day and even greater difficulty is encountered through the fact that the basophilic aggregation count determined on any given day probably is influenced by a lead intake of several days' priority, and possibly as much as two or three weeks. Therefore, no contention is made with respect to a correlation other than the demonstrable fact that in the sustained presence of an atmospheric lead content above that which is tolerable, or in the presence of other lead exposures, such as a proved carrying of lead to the mouth by fingers, there will arise in due time among workers so exposed increased percentages of basophilic aggregations extending beyond the range regarded as usual for unexposed and healthy persons.

In view of statements frequently made that there is no known tolerance to the action of lead, the issue is frequently created as to why all workers under apparently equal exposures do not uniformly present increased basophilic aggregation percentages. The response and explanation leaves no uncertainty as to the rationality of this occurence. The intake per day or per any other considerable unit of time by different workers engaged in substantially the same work markedly varies due to a number of factors, such as the efficacy of the nasal passages as a barrier to the entrance of dust, the rate and depth of respirations, different heights of workers which introduces variables as to proximity of the breathing zone of workers in relation to exposures, the manner in which workers manipulate tools, such as blow torches in the burning operation of storage battery manufacture, and lastly the variations in hygienic habits of different workers as to cleanliness, change of garments, etc. It is therefore expectable and almost inevitable that some workers will exhibit evidences of lead absorption or lead poisoning while their fellows appear to be unaffected.

Summary:

IN AN industrial city, an investigation has been made of work conditions as to lead exposures in a series of very small storage battery manufacturing plants, some of which were operating under manifestly objectionable work conditions. As a part of appropriate engineering hygienic surveys, lead determinations were made of the atmosphere in all operations. Later, and with due regard for an inevitable lag period, basophilic aggregation tests are carried out on the blood of all workers.

In those plants leading to quantitative determinations of lead in the atmosphere in excess of the threshold of tolerability, corresponding basophilic aggregation tests were likewise such as to fall beyond the zone characterizing healthy, unexposed persons. Conversely, in those plants providing no high amounts of lead in the atmosphere, no workers exhibited basophilic aggregation findings beyond the percentage accepted as characteristic of healthy unexposed persons.

Table 2.
Basophilic Aggregation Test Controls
Unexposed, Healthy Adults

Worker	B. A. Cell Count (percentage)
Technician	1.2
Technician	0.8
Technician	1.7
Secretary	0.4
Secretary	0.5
Secretary	0.5
Secretary	0.8
Salesman	0.5
Salesman	0.8
Salesman	0.7
Salesman	0.9
Student	1.0
Student	1.2
Dentist	0.9
Doctor	1.0
Housewife	1.3
Housewife	0.6
Housewife	0.8
Housewife	0.9
Housewife	0.6
Doctor	1.1
Druggist	0.8
Doctor	1.5
Secretary	0.7
Engineer	0.4
Engineer	1.0
Office Worker	0.9
Accountant	0.7
Cashier	0.9
Secretary	1.1
Clerk	0.4
Manager	1.0
Accountant	0.5
Clerk	0.8
Secretary	0.4
Clerk	1.0
Office Worker	1.3
Secretary	0.7

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Fractures of the Spine

—*The Surgical Aspect*—

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IN THIS modern time of fast living, rapid transportation and strenuous playing, fractures of the spine are no longer uncommon.* It would appear that the bony framework which supports the body and covers the spinal cord is no longer adequate to take care of the increased demands made on it. Formerly a rare condition, spine fractures are now quite common. Intelligent knowledge and management of this type of fracture is now demanded of every doctor whether he be a surgeon or not.

When the spine is fractured there are usually two problems with which we are concerned:

First: Compression fractures in which dislocation is not evident by x-ray and in which there is little or no neurological or manometer evidence of cord injury.

Second: Compression fractures in which dislocation and cord injury are evident by x-ray, neurological and manometer findings, either one, two or all.

In the first group are fractures which cause mild or slowly progressive neurological symptoms. These cases usually make a good recovery under competent orthopedic management. They are rarely surgical and certainly never early surgical. Our objective in this class is just the same as in any type of fracture, that is to secure anatomic, economic, and functional restoration. Occasionally for various reasons a proper reduction of this type of fracture is not done early. It may then become necessary to resort to surgery because callus formation and contractions gradually cause cord compression.

In the second group are placed those cases which present immediate evidence of x-ray, neurological and manometer changes. These changes vary from moderate neurologic disturbance to a frank paralysis with complete subarachnoid block. The neurologic disturbance may be due to slight bony pressure, edema, hemorrhage, or cord and dura laceration. The complete paralysis is most always due to bony pressure—especially if it takes place at the time of injury. It is rare that a cord is so torn or lacerated at the time of injury as to cause a complete paralysis. Then too, in most cases a torn or lacerated cord will not cause an early subarachnoid block as will bony pressure. This is an important point to be kept in mind in differentiating the cause of the block and the paralysis. Cases in this group which do not have major manifestations of cord pressure are not surgical. A reduction of the fracture on a Hawley table with use of the fluoroscope is the proper treatment.

Certain cases with bony pressure, immediate paralysis and subarachnoid block call for surgical intervention. I am less inclined to surgery than formerly, and this is because of our results with conservative treatment. We always try a reduction first. This is done on a Hawley table with the use of a shock proof fluoroscope and without anesthesia. I am of the opinion that no fractured spine should be operated until a reduction has been attempted.

Surgery should be resorted to in those cases in which x-ray shows bony pressure on the cord, in in which there is a total paralysis occurring at the time of injury, and in which there is a complete block of the subarachnoid space. It is rare that orthopedic measures help this type. Immediately after attempting an unsuccessful reduction it is wise to remove the bony pressure from the cord. I think it poor judgment to wait on this type of case, and delay means mortality or permanent morbidity. I am aware that certain neuro-surgeons oppose surgery in any type of compression fracture. I cannot see the wisdom of allowing bony pressure to remain on a cord, and when other attempts have failed to remove the pressure, I believe it good surgery to remove that pressure. I am aware that laminectomy does not leave an ideal situation for the patient but it is better than permanent paralysis and slow death.

In dealing with an injury so severe as to cause spine fracture we, in practically all cases, have a patient who is severely injured in other parts of the body. I think a rapid and careful examination should be done before the patient is manipulated in any manner. It is useless to manipulate or operate on the spine of a patient in which there are other major injuries likely to prove fatal. Several years ago we did a beautiful and successful laminectomy on a fat man with a first lumbar fracture and complete paralysis only to have him die four days later from a torn mesentery and ruptured cecum. This experience certainly made me look around more carefully.

Surgical intervention in spine fractures is becoming less popular. This is due to several factors: first, most of these injured who would be considered surgical are fatally hurt; second, the use of reduction under shock proof fluoroscope, and third, receiving these cases after paralysis has existed for 24 hours or longer .

In conclusion I would say that when definite indications exist for surgery we should not hesitate. I would warn against foolishly fast surgery. Most of these cases are referred to us and often times it takes courage to refuse an operation when it is urged on you by a colleague who is a good friend. After all nothing is to be gained by operating on a patient who will get well without it and one who will die with it.

* Presented at the Annual Meeting of the Association of Surgeons of the Atlanta and West Point Rail Road, the Western Railway of Alabama, and the Georgia Railroad, at Atlanta, Georgia, March 30, 1937.

Central States Society

Proceedings of the Central States Society of Industrial Medicine and Surgery, Peoria, Illinois, May 18, 1937.

THE Annual Meeting of the CENTRAL STATES SOCIETY OF INDUSTRIAL MEDICINE AND SURGERY was held in conjunction with the Annual Meeting of the Illinois State Medical Society at Peoria, Illinois, May 18, 1937.

Presiding was the President of the Central States Society, DR. GEORGE W. STABEN, Springfield, Illinois.

The morning session consisted of the following subjects and speakers as given:

"Treatment of Wounds," by DR. DARWIN KIRBY, Champaign, Illinois;

"Injuries to the Intervertebral Disc—Roentgen Study," by DR. HARRY A. OLIN, Chicago;

"The Economic Aspect of Abdominal Drainage," by DR. J. B. MOORE, Benton, Illinois;

"Malpractice in Relation to Industrial Surgery," by EDWARD W. RAWLINS, Chicago — discussion opened by DR. ARTHUR H. CONLEY, Chicago;

"Medical Problems of the Industrial Commission," by DR. PHILIP H. KREUSCHER, Chicago.

The afternoon session was held in conjunction with the Section on Surgery of the Illinois State Medical Society, with the following program:

"The Immediate Treatment of Injuries of the Spinal Cord," by DR. LOYAL DAVIS, Chicago;

"The Immediate Treatment of Compound Injuries," by DR. MICHAEL L. MASON, Chicago;

"Operative Treatment of Fractures of the Neck of the Femur," with moving picture demonstration, by DR. J. J. CALLAHAN, Oak Park, Illinois;

"Electrical Shock Burns and Glare Injuries of the Eyes," by DR. HART E. FISHER, Chicago;

"Injuries of the Semilunar Cartilages," by DR. RALPH M. CARTER, Green Bay, Wisconsin; and

"Growth Deformities Resulting from Osteomyelitis," by JOHN A. SIEGLING, Chicago.

Presiding at the afternoon session was DR. C. PAUL WHITE, Chairman of the Session on Surgery of the Illinois State Medical Society.

Morning Session

DR. DARWIN KIRBY stated that his subject might well be called "The Prevention of Infection," and that in this connection many details were ordinarily overlooked. In many instances of treatment of wounds the whole treatment may consist of swabbing the wound with an antiseptic, putting on skin clips, and establishing drainage. A case history of a small wound of the scalp causing death in three days was cited.

In the appropriate treatment of wounds, benzine and soap and water have been used with considerable success as cleansing agents; the essayist uses an infiltration with novocaine and is particularly concerned about using sharp needles; thorough scrubbing is necessary and the control of bleeding by hemostat; antiseptics are still used; the author prefers to sew up the wound believing that it has been properly cleansed, and to apply a dressing.

Many times what appears to be a simple wound may be deep, and the procedure of properly cleansing the wound helps a great deal.

An important factor is the use of two pairs of gloves, preventing seepage or contamination by puncture. This does not interfere with proper finger exploration. Many times the author has found moisture between the two pairs of gloves without any evidence of puncture visible.

In local herniotomies, two pairs of gloves are also used—it is believed that gloves are a great deal more important than ordinarily considered. In this connection, cultures have been made of the inside of 17 gloves worn by different surgeons—the results obtained may stimulate better hand preparation before operative procedures. Growths occurred in 16 of these 17 gloves, but there may have been some contamination. The significant thing was that one glove in three showed real probability of infection, which demonstrates that careful inspection and hand toilet are necessary.

A case of crushing injury to the leg was cited; debridement was done, vaseline gauze being applied to the exposed tendons; both gas gangrene and tetanus antitoxin were given; Dakin's solution was superficially applied; the patient developed some fever and rapid pulse, and the x-ray showed apparently air bubbles in the soft tissues. Gas gangrene antitoxin and x-ray treatment were given and the patient cleared up and improved. The radiographs on this case were demonstrated.

DR. PHILIP KREUSCHER, in the discussion of Dr. Kirby's paper, expressed great interest in the treatment of open wounds. He had used Dakin's solution, although it had its drawbacks formerly, but it can now be easily made in stable solutions with the proper admixture of sterilized salt solution. It is believed that if morbidity and mortality are to be cut down, one must explore and make debridement early. Dr. Kreuscher prefers to use three sets of instruments. It is true that nobody knows where the living and dead tissue separate in wounds, and it is better to take some live tissue than leave some dead tissue.

DR. WILLEMS was interested in hearing this discussion of gas bacillus infection, and believed that it was a good idea to have our attention called to such things from time to time.

DR. HARRY OLIN stressed a point of caution in gas bacillus infection, with which there was considerable experience during the war. When the x-ray is made, there should be no splints nor dressings on the extremity because these may mask the shadow of the soft tissues and prevent visibility of gas bubbles. One should also use an x-ray without a filter, as this will bring out the gas bubble appearance. Important it is to keep in mind that evidence of gas bacillus infection will appear in x-rays before surface crepitation can be elicited. Bacterial cultures take about six hours, and the x-ray evidence can be secured before such returns are available.

DR. HARRY OLIN in speaking about "Injuries to the Intervertebral Disc," first demonstrated a cadaver preparation of the spinal column which showed the intimate relationship between the vertebral bodies and the intervertebral discs.

A great many times the disc is ruptured by some violent action, particularly sneezing. Recent work by the Mayos mentions protrusion of the disc into the spinal canal.

The problem here is to recognize an injury showing the presence of few characteristic symptoms. The x-ray gives useful information. In compression fracture of vertebral bodies, the disc is involved in approximately 80% of the cases. Often there is a protrusion of the nucleus pulposa. Anatomical research studies have brought many reports into the literature. Many injuries of the spine involve the disc, compression of it and extrusion of the nuclear material .

Historically, Vesalius described such an injury in 1555. More recently Schmorl has shown that 38% of cases at autopsy showed an involvement of the disc in spinal injuries.

In considering the anatomy, the disc is the buffer between the bodies, and there are 23 of these discs in the spinal column, thicker in front in the cervical region and the lumbar region, but fairly uniform in thickness in the thoracic region. Discs thin with age, thus diminishing the height. The disc is composed of three parts, the annulus fibrosis which surrounds the central fluid or nuclear material and two thin cartilaginous plates.

Functionally, the disc acts as a buffer and changes shape with different types of stress. Various movements of the spine were described and the changes in the discs were also described—in flexion, in extension, lateral movement, circumduction, and rotation.

Pathologically, having in mind the anatomical and functional relationships, the pathological changes may be readily understood. Schmorl concluded that nuclear prolapses were of little significance. Other investigators have believed that symptoms were produced in relation to encroachment upon adjacent structures. The commonest lesion is prolapse forming what is known as a Schmorl node in the spongiosa of the vertebral bodies. A sclerosed margin of bone surrounds the nodule after the elapse of sufficient time for its formation and this can be seen in the x-ray, the node varying in size from the head of a pin to the end of the thumb.

This injury occurring so often after violent sneezing, the joint space may be narrowed and the disc may be subsequently totally destroyed, in certain severe injuries. Bony changes may occur in the articulating facets of the vertebral bodies. If there is no regeneration of the disc, slight kyphosis may follow, necessitating a fusion operation. Prolapse of nuclear material may occur in any direction and protrusion may occur into the spinal canal, which however, may cause only slight reduction of the disc size.

Peet and Nichols reported records of 50 cases of nodule formation. These investigators concluded that if a clinical diagnosis of spinal injury had been established, one should always consider retropulsion of the nuclear substance. Classifications have been reported by other investigators.

The importance of good lateral x-rays for diagnostic purposes cannot be overemphasized. The relationship of repeated trauma and sclerotic processes of the disc and the relationship of osteoarthritis of the spine are important considerations.

In summary, a review of the literature has been presented on injuries to the intervertebral disc, based also upon 51 cases of the writer. This condition is a distinct pathological entity. We are indebted especially to Schmorl for his researches in this field. Extrusion of the nuclear substance is a common finding, some investigators claiming 80% involvement. A lateral roentgenogram plays an important part in diagnosis. We must also consider injuries to the intervertebral disc as a working factor in osteoarthritis.

Lantern slides were then shown including the anatomy demonstrating the intimate relationship of the vertebral body and disc—median section showing nucleus pulposa surrounded by the annulus fibrosis and cartilagenous plates, also ligamentous relationships—demonstrations of axes of motion—rupture of the nuclear material and lipping of vertebrae — production of Schmorl's node — herniation of nuclear material—classification of primary and secondary clinical effects—x-rays of typical Schmorl's nodes—fracture of first lumbar body, anterior and lateral views—compound fracture of body with narrowing of disc—fracture of body and involvement of discs and lipping—narrowing of space and deformity—fracture of body of seventh cervical with narrowing of disc—calcification between bodies—injury to disc, showing injury to body also four months later—cervical dislocation of body of fifth and fracture of pevicle. In the author's series there were six cervical injuries, 15 dorsal and 29 lumbar; in a total of 50 cases, the disc was involved in 42.

Dr. L. S. Tischy, in the discussion of Dr. Olin's paper, said that he had been on the lookout for herniation of the nuclear material, but he had not seen it very often. He would like an explanation of the degenerative changes which occur on the basis of injury to the nuclear material. He had rarely seen secondary changes except in hard-working laborers. He believed that the paper was very illuminating in explaining symptoms in cases of so-called traumatic back.

Dr. Philip Kreuscher thought this was a timely subject and helpful in the explanation of cases difficult to diagnose. A case of injury to the nucleus pulposa after spinal puncture was cited. Dr. Charles Pease collected a series of injuries to the intervertebral discs, several years ago in Chicago. The point to be remembered is that this injury does happen and there are cases on record. A case of this injury in a football player was cited, the diagnosis not being made until an x-ray was taken several years later. In cases of tuberculosis we do not usually have the nuclear material involved, but in fractures of vertebral bodies, where comminution and spicule formation occur, it is reasonable to believe that the nuclear material may be involved. Cases should be studied not for a matter of months but for several years. The x-ray diagnosis should be made by a competent man who has had experience with this type of cases.

Dr. Olin in closing, agreed with Dr. Tischy that osteoarthritis occurs in the middle-aged hardworking person, but it is seen in the young. A number of cases were cited in persons not doing hard work. This injury can be produced experimentally in dogs by mechanical trauma of the vertebral plate. Dr. Kreuscher made a very significant point when he stated that it was important to x-ray backs at considerable time after the injury, as well as immediately after the injury.

DR. PHILIP H. KREUSCHER, introducing the subject of "Medical Problems of the Industrial Commission," said that it was necessary to understand the compensation act and also the industrial diseases act; it might be desirable to secure legal interpretation. In his talk, Dr. Kreuscher would include the problem of disability—the malingerer—the true and fake psychoneurotic—the pneumoconioses — and finally, arthritis and hernia.

How do you estimate disability? It is easy enough, for example, to estimate a 65% disability, but how do you arrive at such a figure? What terms do you think in? Do you depend upon the physical examinations? Not altogether. Do you depend upon the x-ray? Somewhat, but not altogether. Do you depend upon the history? Somewhat, but not altogether. In fact, one must take all three into consideration and then one will be wrong enough of the time.

The legal provisions are rather clear regarding the general principles of disability: one must consider (1) the reduction of earning capacity; (2) loss of efficiency for the specific vocation followed; (3) structural loss; (4) cosmetic defects; (5) ability to again secure employment like that previously followed; and (6) definite loss of function.

Reference to schedule of payments was made—the essayist did not believe that this schedule was adequate at present. In injuries to the hand, the type of plastic work done by the surgeon is often influenced by the disability schedule payments.

Usually a surgeon depends too much on x-ray evidence and neglects injuries to the soft parts, for which no legal provisions are ordinarily made. Such injuries should receive more attention and their importance should be understood. Is the threshold of fatigue lowered in the muscle or muscle group? Has there been a severe injury to the periosteum which may present an entirely different problem from bone injuries? What of the interference with proper circulation? Has the man had Buerger's disease? In all these things, the surgeon should put himself in the place of the injured employee.

In regard to hernia, the important points are the estimation of disability—whether the hernia is truly traumatic which occurs rarely, and the type of strain and work. Compensation provisions include the following headings: (1) the hernia must be of recent origin; (2) it must be accompanied by pain; (3) it must be immediately preceded by trauma related to the employment; (4) the employee must have had no previous hernia. Even when considering seriously all these principles, it finally comes down to a matter of personal judgment.

Arthritis is an ever-present problem. The arthritic is going to be injured at some time, by relatively a slight degree of trauma; he is then x-rayed and arthritic changes are then found for the first time. We have to keep in mind that the arthritic is easily injured, that he recovers slowly and that the aggravative factor will undoubtedly arise in adjudication of cases.

In the detection of malingering, many procedures of detection have been used by DR. ARTHUR CONLEY. It is in injuries of the head and spine that the cases are difficult. Such cases are often settled on account of their peculiar type and many times the man is not paid what he should have been.

The problem of the psychoneurotic is one of great difficulty—made more difficult by the government regulation of paying 100% disability after diagnosis. Whether this principle is correct or not is not for our decision here, but it puts industry in a bad position.

With regard to the pneumoconioses, the recent act has created considerable interest. At first there was considerable of a flurry in the smaller industries, especially the self-insurers. A lot of wholesale examinations were done, there were differences in diagnostic impressions, appeals have been made to the Commission for settlement of these differences when men have been discharged on questionable findings. Apparently the situation is calmer now and will continue to be so. Only a Supreme Court decision will finally settle some of the difficulties.

It is felt that it is the best policy to pursue at the present time to remain quiet. If we make special examinations for silicosis, then we are liable to have to make special examinations for other things, such as syphilis, heart disease, arthritis and others.

In regard to the adjudication of claims before the Commission, if an employer once gets the reputation for being fair, this attitude will make a great difference in the settlement of claims.

DR. V. S. CHENEY, in the discussion of Dr. Kreuscher's paper, believed that the only defense against the principle of aggravation is the consistent use of pre-employment and periodic examinations. All examinations should be done for the purpose of proper placement and not discrimination. But we should know the physical status of the employees. The extent of the examination varies naturally with the nature of the industry and the occupation. His company has always tried to be fair to the employees. Good surgery regardless of payment of compensation has always been the aim.

DR. J. B. MOORE, of Benton, Illinois, then spoke on "The Economic Aspect of Abdominal Drainage." This subject is important because of the necessity of trying to get away from bad after-effects. It was the practice of the essayist when in doubt to drain a wound. It is the best principle to observe to have a preconceived plan which is adaptable—before problems arise.

In the male, postoperative hernia most often occurs on the right side. It is thought best that the appendix be reached through a muscle splitting incision which will give more rapid healing and less bad after-effects than other types of incisions in this location. As a case in point, the bad after-effects following a right rectus incision were described.

In females, we see too many difficulties following midline incisions. It is recommended that the vaginal route be used more often in draining the pelvic area.

Finally, we should emphasize careful consideration of the acute abdomen in young persons; the more frequent use of muscle splitting incisions; and the management of a case in such a way as to avoid complications.

DR. DON DEAL, in the discussion, agreed with the procedures as outlined by Dr. Moore.

DR. OTIS thought it important to maintain a proper wall of support to prevent herniation. With this principle in mind he began avoiding wiping the fascia and injuring blood supply. He is now

convinced that this is a definite procedure which will help to avoid sloughing of tissue. This simple procedure will assist men to return to work more rapidly.

DR. MOORE, in closing, was pleased to emphasize the point made by Dr. Otis of the importance of avoiding trauma to tissues during operations.

EDWARD W. RAWLINGS, in talking about "Malpractice in Relation to Industrial Surgery," believed that the subject was endless in its ramifications, but would touch on a few points.

The duty imposed upon the physician and surgeon is that of "ordinary" care. He need not be the most expert and should not be the most incompetent.

Very often trouble arises because of the unconscious attitude of criticism of another medical man, even though this criticism may not be actually expressed—it need only be implied.

As an example of the difficulty in these situations, the text of a decision of the Oregon Supreme Court was cited. From this it is seen that it is manifestly unfair to criticize those who are less experienced and less well informed.

The laws on this subject are quite fair in Illinois; in most instances the burden of the proof is on the preponderance of medcial evidence introduced.

In industrial practice there is a different situation from that in private practice, the former having the element of economic pressure in settlement, which introduces the possibility of bias.

It should be understood that the settlement of injury claims is a bar to further action. An important point to remember is that changes should not be made in operations or different operations performed than were provided for in the consent before operation.

DR. ARTHUR CONLEY, in opening the discussion, believed that this is an important subject at the present time because there are probably more malpractice suits pending now than at any previous time. The reason seems to be that many patients were carried along through the depression on a credit system and finally never did get around to paying the doctor, although they had prospered; in suing the prosperous patient, one ran against the statute of limitations and thereby opened up a malpractice suit.

MR. RAWLINGS, in closing, answered a number of questions which involved the following principles: In operating on a minor where there is an emergency and the parents cannot be located, it is the surgeon's duty to go ahead and do the necessary work.

The difference of age of consent in boy or girl is 21 in the former and 18 in the latter. The statute of limitations does not begin to run until one becomes of age.

In regard to x-ray burns, we know so much more about the control of such things now than formerly that this is a principle which should be kept in mind.

In carrying cases up to the higher courts, care should be used in establishing precedents that are stable.

Afternoon Session

THE afternoon session was held in conjunction with the Surgical Section of the Illinois State Medical Society, the Chairman of that Section, DR. C. PAUL WHITE, presiding.

DR. LOYAL DAVIS gave the first paper, on "The Immediate Treatment of Injuries to the Spinal Cord."

Damage to nerve roots complicates treatment. The determination of proper diagnosis and the choice of therapy present difficult problems. Such injuries usually occur by violent flexion or extension of the spinal column, and may be accompanied by fracture or dislocation of the vertebra or fracture of the lamina or processes. Hemorrhage may occur. There may be a partial to complete section or compression of the cord.

Lantern slides were shown depicting the following principles: (1) diagram of cord segments and nerve roots (important to keep in mind that segments and spines do not correspond); (2) diagram of muscular groups, function and enervation and relationship to reaction or movement illustrated; (3) sensory enervation diagram; (4) upper motor neuron and lower motor neuron lesions and their effects.

Complete physiological interruption of the spinal cord cannot be differentiated from complete anatomical section—both produce complete sensory and motor paralysis below the level of the injury.

Complete transection of the cord may produce a stage of muscular flaccidity—next a stage of reflex activity—and finally, a stage of reflex failure; the patient may die, however, in any stage.

The most discouraging experiences are found in reference to cervical lesions, which occur principally by auto injuries or by diving in shallow water. The time of the operation is apparently not significant in these cases.

In the involvement of the thoracic cord we usually have the eighth to the twelfth dorsal vertebrae affected; lumbar vertebrae are most frequently injured by falling on the buttocks or on the extended legs and involve the cauda equina.

Surgical interference often depends upon block of the spinal canal or bony encroachment. One can only hope to reduce mechanical obstruction.

General principles of treatment include placement of patient on a water bed—the use of retention catheter by which the urine is drained off every four to five hours—especial attention to decubitus, by cleanliness and the use of the ultra-violet rays.

As to after-care, there should be proper splinting, avoiding foot drop—the use of the Hubbard tank for passive movement of extremities—and the application of walking apparatus in front of a mirror for re-education in walking movements.

DR. MICHAEL MASON, in speaking of "The Immediate Treatment of Compound Injuries," stated that the object of such treatment was the restoration of morphology and function. The presence of contamination is of the greatest significance—infection is a disturbing element. Formerly our attention was focused upon antiseptics—asepsis is now important. We have been through a veritable flood of antiseptics, but the war brought us the lesson of asepsis. The goal is rapid and proper healing and restoration of morphology and function, doing no harm to the tissues by restorative processes.

Important principles to remember are the removal of dead tissue, the proper repair of tissue,

the closure of the wound, and putting the part at rest. After six hours the wound is infected and is no longer contaminated; thus there is a distinction between contamination and real infection. Mechanical cleansing is of the greatest importance and antiseptics are not dependable, and may definitely retard healing. Cleansing of the surrounding skin should be done with cotton, soap and water after covering the wound with gauze; the gauze is then removed and the wound itself is cleansed carefully; excision of devitalized tissue is then accomplished and the crushing injury offers the most complex problem here; the deeper tissues should be excised slowly and carefully and the careful repair of divided structures accomplished with the use of fine materials and instruments rather than coarser ones. Proper experience and equipment are needed. The primary closure is desirable where possible and in this, one may use skin grafts, the free graft being preferable. Rest and splinting have been found to be very helpful.

Slides were shown depicting primary repair of finger tissue by the use of graft—partial loss of finger repaired by pedicle flap—severe abrasion of skin and loss of skin from severe crushing injury illustrating excision method and graft—also instances of loss of portions of fingers.

DR. J. J. CALLAHAN spoke about a new technique in operation for fractures of the neck of the femur. Many methods have been tried by the staff. One was not satisfied with the results obtained from conservative methods of all kinds. Finally, it was possible to adapt the principles of an instrument which came from Peru. Dr. Scuderi reconstructed and adapted this principle, devising the apparatus. Incision went through only the vastus lateralis muscle in using this apparatus and inserting the flange through the greater trochanter into the head. X-ray photographs of illustrative cases were presented.

The technique of this operation was beautifully illustrated by an excellent colored motion picture in which the operative procedures were all clear and not obscured by the operator's hands, such as is often the case in motion pictures of this sort. In the postoperative treatment, the Thomas splint is used in some instances, but one usually depends upon the flange to hold the structures in place. It is of greatest importance to get motion in the knees and hips during bed treatment and this is started as early as possible.

It is believed that this method offers the best results of any one devised up to date.

DR. WM. R. CUBBINS, in opening the discussion of these papers, thought that an important statement had been made by Dr. Davis regarding the practical impossibility of differentiation of physiological and anatomical section of the spinal cord. Dr. Mason's statement about cleansing of wounds was also very important. It is believed that one should allow for drainage of fluid in certain types of wounds.

DR. HART E. FISHER, of Chicago spoke on "Electrical Shock Burns and Glare Injuries of the Eyes."

There has been an increase of electrical accidents with the increased use of electrical energy.

Slides were presented showing the New York experience in 1931 in which electrical accidents constituted 4% of all industrial accidental deaths. The data also showed that electrical injuries always provide a longer disability period than all other accidents.

During 1929-1933 the number of deaths from electrical injuries dropped, but these are again rising. The age incidence is mostly in the prime of life. The sources are lightning, industrial accidents, and home accidents. The sources for research are animal experimentation, electrocution and accidents.

We are now more fearful of the effects of low voltage exposures than formerly, because of association of this type of exposure with ventricular fibrillation. Intensity, or amperage, is important. The alternating current and the direct currents are equally dangerous; 60-cycle current is dangerous, but the 25-cycle current is even more dangerous.

Factors determining the severity of electric shock vary according to the route of the current, the resistance of the skin, the wetness or dryness of contact, the size and position of the electrodes, the duration of the exposure, and other factors.

Slides were shown illustrating the various types of exposure, such as the use of washing machines, kite flying, the use of metal measuring tapes by linemen, the throwing of switch with one hand supporting against metal rod, third-rail work, and the use of rubber goods for protective purposes.

Variation in fatalities has a distinct relationship to the location of electrodes to different parts of the body. Rescue methods and resuscitation methods were detailed.

Reference was made to the army shoe which has so much metal in the soles, as being a distinct hazard in electrical exposures.

Fatalities occur most frequently approximately three hours after meals and mainly in the summer months. Fatalities increase in frequency according to the following factors, in order—victim was able to free self from contact—victim fell or was thrown from contact—victim had to be rescued and resuscitated.

Special mention was made of resuscitation methods, and the Schafer Prone Pressure Method of Artificial Respiration. Mention was also made of the use of the Drinker respiration tank. A photograph of Hyman's electrodes for special treatment of the right auricle was shown.

Finally, great stress was laid on persistency in resuscitation—since there are frequent instances of where the patient has been pronounced dead by a physician and later resuscitated by a layman who was thoughtful enough to use the proper administration of the Schafer Prone Pressure Method.

DR. RALPH M. CARTER'S paper on "Injuries of the Semilunar Cartilages" was read by DR. JAMES FINCH.

Although this is an old subject, it still remains an important one because of the great amount of disability occurring when improper treatment is given. There are also many misconceptions as to results of treatment.

In many instances there is a twist which is distinctly related to the production of semilunar injuries; many times this is accompanied by a misstep or a fall.

A correct pre-operative diagnosis is most im-

portant and there should be clear indications for operation; if exploratory operation is done, the patient and the relatives should understand why and also the nature of the operation.

Careful history is important, and usually shows attacks of locking and swelling with consequent disability.

The examination may show fluid or not and there may be tenderness at the anterior attachment of the cartilages. Despite the fact that cartilagenous substance is not ordinarily visible in the x-ray, an x-ray should always be made.

Operation offers the only permanent help, although conservative methods may be successful occasionally. There should be rigorous aseptic technique—a tourniquet serves to keep the field bloodless—a long internal or lateral incision is preferable—damaged cartilage should be entirely removed and the joint cavity explored—a tight bandage is applied after the usual sterile dressing —no splinting is necessary and there should be gradual motion—morphine may be used for the first two days postoperative to keep the patient comfortable. Tapping should be done for postoperative collections of fluid.

Finally, six to eight weeks is an average period after which occupation may ordinarily be resumed.

DR. JOHN A. SIEGLING, of Chicago, presented the final paper on the afternoon program on the subject "Growth Deformities Resulting from Osteomyelitis."

Lantern slides of epiphyseal lines in the long bones of children were shown.

Of 423 cases of osteomyelitis, 277 occurred in children and 241 in the long bones. All of these bore a definite relationship to arrested growth, by interference with the epiphyseal portions of the bone.

It is important not to cross the epiphyseal cartilage in surgical operations—as this will frequently arrest the proper growth.

Roentgenograms of the arrest of growth in the various bones were demonstrated.

The use of the arrest of growth principle in matching limb lengths, however, was shown to be of importance and designated as surgical arrest.

Finally, one should always keep the possibility of growth arrest in mind and an explanation should be made to parents of the child patient.

In the discussion of Dr. Fisher's paper, CHAIRMAN WHITE asked about the frequency of tetanus in electric burns. Dr. Fisher replied that as an example of what was considered to be an average experience relative to the importance of tetanus, only 10% of two large series of burns received antitoxin treatment. Chairman White cited the case of a lineman who fell on to a grass plot and later developed tetanus as an example of what he had in mind.

AT THE annual meeting of the Board of Governors of the Central States Society of Industrial Medicine and Surgery, the following officers and board members were elected (including replacements of the Board of Governors) for the year 1937-1938: President, DR. F. W. SLOBE, of Chicago; Vice-President, DR. DON DEAL, of Springfield; Secretary-Treasurer, DR. FRANK P. HAMMOND, Chicago. Replacements and additions to the Board of Governors included DR. GEORGE W. STABEN, Springfield; DR. W. M. HARTMAN, McComb, Illinois; DR. HAROLD A. VONACHEN, Peoria, and DR. RALPH M. CARTER, Green Bay, Wisconsin.

Medicine in a Changing Era

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THE present is no moment for the medical profession to be too lazy to think or too slow to act upon the future planning of medical practice.* There are today, certain groups, without medical training, who are trying to force their visionary thoughts as the material from which to make a new pattern of medical economics. Added to these groups, who would dominate the medical practice of tomorrow, are the ever-rising new cults and the age-old charlatans, both appealing to the superstition and ignorance of the people.

It is believed that a group will appear before the 1937 Congress to bring "Health Insurance" as its new pattern of medical economics. This question will be decided, not upon what the doctors want, nor even upon what the well entrenched "Social Workers" and other politicians who are making such wasteful inroads into our taxes want, but upon what the people of these United States decide they are going to have. This is why it is important that every medical man in the nation familiarize himself with just what this brand of socialism, "sugar coated" for the public as "Health Insurance," actually means to the people. He should then, through all available channels, make the facts known. The people who are enlightened on the subject do not seem to want it.

In the first place, it isn't health insurance, because the sickness and death rates in the countries where the plan is in operation are higher than in the United States under the present system of medical practice; and in the second place, it isn't insurance because the contributions to pay for it are compulsory—which means taxes. Instead of calling it "Health Insurance," the proper title should be "Sickness Tax."

The plan will provide for less than half the people, i.e., the industrial workers from whose pay envelopes it will be easy to take tax. The farmers, small shop keepers, professional men, and those who own their own businesses will not be included. The indigent and unemployed will still have to be cared for by society in general, as they are now, and this will require more taxes. Remember this: Almost half our population is indigent or nearly so. The medical profession is paid for only about one-tenth of the service it renders the indigent.

The proponents of state medicine will have no great trouble in convincing the urbanite of its value. The numerous free clinics and hospitals with the "Come One, Come All" policy, aided and abetted by the gullible physician, ward politician, social service worker and financial investigator, vividly demonstrate to his satisfaction that medical service should be furnished free by the State or National Government, and the money saved by this arrangement converted into gasoline for week-end pleasure trips or perhaps a new radio.

In small towns and rural districts the situation,

* President's Address, Annual Meeting of the Surgical Association of the Atlanta and West Point Rail Road, the Western Railway of Alabama, and the Georgia Railroad, at Atlanta, Georgia, March 30, 1937.

at present, is different. The local physician knows almost everyone. He requires no intermediary to tell him who deserves charity. He knows,—and the deserving are seldom if ever neglected. The physician-patient relationship is personal, and a change could not be easily be brought about.

Well known are the broad deleterious effects of socialized medicine on the practicing physician. But what would be the immediate effects on him of such a system in the United States?

Temporarily it would tend to stimulate his practice. More patients would come to his office. He would be kept busier than usual. Some enhancement of his revenue would be noticed. For awhile the system would herald a period of seeming prosperity. Only gradually would the drawbacks become apparent. An excessive volume of work at cut rate fees; widespread malingering with its drain on the physician's time; deterioration of standards; grafting and chiseling to make a decent living; solicitation of patients; making a business out of certifying cases; increased morbidity and mortality, and added competition from cults (any representative of the "healing arts" could be consulted legitimately by insured patients). Unless blocked by the medical and allied professions, the health insurance legislation will be passed at an early session of Congress, thus completing the third leg of the "Social Security" structure.

A MENACING factor that comes from within the very heart of the profession is the careless observance, by some of the hospitals, of the medical practice act. It does not strain the imagination to foresee them offering a flat rate charge for appendectomies, tonsillectomies and obstetrics—the hospital receiving the fee and the patient's gratitude and the doctor getting the experience. Free clinics and charity hospitals are doing a wonderful work. They always have and always will. In many cities, however, the abuses in some of these institutions are flagrant and well known to every medical man.

Other groups, that continue to harrass the profession by appealing to the superstitions and ignorance of the people, are composed of "new cults" and charlatans. With money to back them, members of these cults have no difficulty in influencing the vote of those of similar ilk who occupy seats of legislative prominence. (The 1937 session of the Georgia General Assembly is a fair example of a cult securing political strength to block organized medicine in its effect to improve the standards of education in all forms of the healing arts.)

Today, as always, charlatanism lies in the wake of medical progress. In England, during the era ending with the reign of Elizabeth, covering the entire dynasty of the Stuarts and through the first 40 years of George the Third, there were two centuries of brilliant achievement in literature and the drama. Medicine, backward for 20 centuries was just awakening from false theories and throwing off the cloak of ignorance and superstition. From William Harvey to John Hunter a definite development in medical skill was made. During this era, however, quackery flourished to such a degree that many types of cure-all pills, elixirs and appliances were sold. The quack plied his trade in one locality until the arm of the law reached for him, then he would quickly move to another.

Charlatanism seems to be about the same in all eras of the world's history. Eighteenth century Perkins tractors are not unlike the recent Abrams machine or the spine pounders' neurocolometer; seventeenth century "elixirs of life" may be dubbed in our generation "Tune Twisters' Remedy" or "Madam Barnyard's Pink Pills for Pale People."

Together, the modern cultist and charlatan have organized their efforts, backed by legal standing, to invade the field of medicine. Their unscrupulous methods and absolute ignorance have taken high toll. The radio has supplanted the old fashioned handbills and itinerant medicine shows of a few decades ago. This marvelous means of communication is, at times, permitted to allow sponsors of dangerous therapy and questionable remedies to attempt diagnoses and advise treatment.

It is not surprising then that over four million pounds of actyl-salacylic acid were consumed in the United States during 1936. Less than 1% of the amount was prescribed by physicians. Nor is it surprising that the bill to regulate the sale of the barbaturic acid drugs died in the committee of the General Assembly of Georgia just adjourned. It is therefore, the duty of every physician to acquaint himself with all proposed plans affecting the practice of medicine, separating the good from the bad and enlightening the public concerning these plans.

FROM the outside then the medical profession is confronted with "Health Insurance," new cults, quacks, and unbridled radio's pernicious cure-alls. From within, has any formidable and worthwhile solution appeared? Time will answer that question. But let us briefly discuss some of the more popular plans proposed.

Group hospitalization is making rapid progress and deserves careful study. At present it is estimated that more than 700,000 individuals are members.

Is group hospitalization sound and ethical? In the February 1937 issue of *Medical Economics* the question is answered as follows: Testimony from a number of individual physicians and medical societies supports the following conclusions:

The physician-patient relationship under group hospitalization is not disturbed, and in representative projects, free choice of hospital, by patient and doctor, remains intact.

Low income patients find it possible to pay their physicians since they are relieved of the burden of a large hospital bill (thereby reducing the need for tax-supported medical services.)

There is no interference with existing organization of hospital staffs or with the medical judgment of the individual members.

Dr. M. L. Stevens, former president of the North Carolina State Medical Society, says "I look upon group hospitalization as I do upon accident, health and life insurance. Not as a possible entering wedge for state medicine." However, Dr. Daniel P. Griffith former Vice-President of Connecticut State Medical Society, foresees the accumulation of surpluses by the groups which will bring about additional benefits, including probably services rendered by physicians—since many hundreds of young physicians are, relatively speaking, unemployed, it would be a simple matter to make arrangements for providing medical care at nominal fees.

IT SEEMS then that a plan to be workable should contain at least these three principles:

1. The exclusion of all types of medical service—specifically laboratory, roentgen-ray and anesthesia (this to be clearly emphasized to avoid misunderstanding as to what constitutes medical care.)

2. Active inclusion of the County Medical Society in the program of the organization.

3. Admission of patients to hospitals only on recommendation of their physicians.

It is believed by many that group hospitalization offers the average man better protection than medical reimbursement insurance.

It is less expensive and pays a larger percentage of service rendered for either illness or injury. People who can afford a combination of the two have found it an excellent way to meet the costs of disease and disaster. With that combination only one medical obligation is not covered—fees to the physician for treatment of sickness. However, in some localities medical societies have inaugurated a monthly prepayment plan whereby people in the low income group are assured that the physician of their choice will be paid.

This feature in itself deserves some attention when we find that last year not more than 75% of medical bills were collected successfully. In addition to the enormous debt represented by outright free services, the American physician had to write off more than a quarter of all the fees due him from his paying practice.

Thus group hospitalization and also a prepayment medical service plan have been offered as an effort to help in the revival of the failing economic system.

The groups that offer "Health Insurance," the cults and charlatanism, are built upon bargaining. The practice of medicine has a cherished and unique history. No other profession, science or industry has ever been organized upon a code of conduct. This code need not be changed, for it was not reared upon competitive gain, but upon moral principles and ethics that have remained unshaken for over 2300 years. It has been said that the moral debacles which have occurred in industry, public utilities, banking and so on have not taken place in medical practice, and will never take place as long as physicians follow the precepts of the Hippocratic Code.

Followers of this code are in a continual struggle for a better understanding of life, illness and death, such devotion to duty being exemplified in the individuals who follow the teachings of a noble profession—incomprehensible to those who "drive a trade"; who do not understand the sacred obligation of physicians to their patients.

As a nation we may be sentimental, but we are also practical. We do not suddenly cast out good policies nor scrap institutions which have fulfilled good purposes, but we are ever desirous of adding things of proved worth, recognizing that there are values in individualism that transcend collectivism. They are the values of our deeper emotions, of our pride in our profession, of our cultural desires; and it would be intellectual death to relinquish them. Let us be ever alert and mindful of medicine's position in this changing era, and let us make a supreme effort to preserve forever, *individualism*, that ancient and treasured heritage of our profession.

Treatment of Wounds

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Champaign, Illinois

THE subject of this paper might rather be "Prevention of Infection" instead of "Treatment of Wounds."* Since the organization of industrial surgeons at Decatur, Illinois, several years ago, I have been a fairly faithful attendant. This has not been due alone to my interest in industrial surgery, but because of all the meetings I attend I feel that I learn most from this one, especially our clinical meetings. To me they are a postgraduate course, and I always take home something of practical value that I can apply in my practice. It was this that made me hesitate to appear on the program. I fear that I have little to offer you. I am convinced, however, that many physicians overlook details in the treatment of wounds that perhaps seem unimportant, but if observed may make for quicker healing which is pleasing to the patient and, to say the least, agreeable to the insurance company.

I commonly see a small wound swabbed with an antiseptic, I will not enumerate the many favorites, and a suture or skin clip taken, constituting the whole treatment. Several years ago the taking lightly of small wounds was so indelibly impressed upon me that I want to relate the case responsible. A shop man fell on the slippery street and received a small scalp wound. The treatment consisted of an application of tincture of iodine. I saw him about a week later at which time there was great tumefaction over a large area of the scalp, but no fluctuation. The next day the whole head was involved and swollen to what appeared about twice the normal size. Three days later he was dead.

My procedure in treating small wounds is first to cover the wound with a piece of gauze and with an applicator or sponge cleanse around the wound a path from one-half to one inch wide with benzine, soap and water, dry and paint with an antiseptic. I then infiltrate or nerve block with 1% novocain using a very small sharp hypodermic needle.

You notice that I emphasize about the needle, small and sharp. I always keep a dozen new needles in the office and when one becomes the least bit rough or dull I throw it away, never sharpen it. The best test I know for this is to pull the point between the thumb and forefinger, the least bit of cling or roughness means that I would not want it used on myself. The next step is a thorough scrubbing, on the hand or foot a scrub brush is used. This is often quite displeasing to the patient, but after he finds out that it does not hurt or but little, he quits growling. As a rule however, gauze is used. This is hard on the sterile supplies as many sponges are needed. Profuse bleeding is often started up which is allowed to help wash out the wound or is controlled by pressure or a hemostat. The parts are then painted with any antiseptic, why I still use them I do not know.

Gauze from a five-yard roll is used to make a sterile drape and I am ready to sew up. I used to keep sterile compresses and towels, but for the past several years I have used sterile gauze sponges

* Presented at the Annual Meeting of the Central States Society of Industrial Medicine and Surgery, Peoria, Illinois, May 18, 1937.

and the five yard rolls which I get from the drug store.

It is surprising what a comfort this method is to the patient and myself; no pain on his part, no hurry on mine. The most illuminating thing is when a wildly crying child is treated this way, it soon quiets down and by the time we are sewing up, it thinks that we are playing some kind of game. Again, what appears to be a superficial wound may turn out to be quite deep with a severed nerve or tendon. This may be repaired immediately and just as good a result obtained as at the hospital. In fact, the other day I started to treat a complete palmar wound, no tendons involved, in the emergency room at the hospital, found one of the digital nerves severed, did not have to take patient to operating room and give general anesthetic as the local held sufficiently.

FOR the past several years I have been doing something in the treatment of wounds which I have carried over into my bone and tendon work. I have stated above that I have become satisfied I can prevent infection in any small ordinary wound by scrubbing which is made possible by local anesthesia. If then an infection develops I believe that I carry it in. While masks are necessary, I believe one of the most important factors is gloves in bone or tendon surgery. Further, when doing this work I always wear two pairs of gloves. I have reasoned that we use instruments with impunity in bone grafting and plating, but do not allow the gloved fingers to touch the operative field. To start with, the glove is as sterile as the instrument, therefore, the danger must be in the leakage, through puncture wounds and small imperfections which allow infective perspiration to contaminate.

Since using two pairs of gloves I have not hesitated to use my fingers in any part of the wound. One might argue that this will lessen the delicacy of touch, perhaps a little in tendon work, but in bone work it is much easier than doing everything with instruments, especially the tieing of sutures. I have been doing this for the past several years and to date have not had a single infection. Often when wearing two brand new pairs of gloves, on removal I have found moisture between the pairs. Very careful examination has many times failed to disclose any imperfection or puncture.

Recently I have had occasion to do quite a few herniotomies which were paid for by insurance companies so I decided to add these to my bone and tendon class. I was stimulated to this after having been associated in a case where I was called upon to testify regarding pain which persisted long after the operation. There had been some infection following the heniotomy and whether or not this was responsible, there was a prolonged convalescence and neither the patient, the employer nor the insurance company was very well pleased. These herniotomies were all done under local and I did not find myself handicapped by the extra pair of gloves. I may add that there was healing by first intention in every case. I am strongly of the opinion that many so-called "stitch abscesses" are not due to the suture material as often as to defective gloves.

I have lately been carrying on a series of experiments at the Burnham City Hospital in Champaign, through the kidness of the laboratory technician and the surgical supervisor. Immediately after gloves are used a sterile swab is inserted into the index finger and then placed in a culture media. This is taken to the laboratory where plating is done and identification of organisms made. To date we have cultured the inside of 17 gloves, each from a different surgeon.

Every physician is given a case number and it is the intention when this work is finished to advise anyone who has a large bacterial count. It is hoped that this may stimulate him to a more careful hand preparation. We are finding quite a variety of bacteria, both of bacilli and cocci. One factor has entered in which we think must be contamination and that is the finding of moles. Of the 17 gloves cultured, growths were found in 16. This we think should be discounted because of contamination. There was definite growth in 10, or 60%; six showed staphylococcus, or 35%. I feel that this is the only figure that is very important; one glove out of three showing possibility of causing infection.

We are not maintaining that it is necessary to wear two pairs of gloves, due to the fact that we have found infective perspiration. It is perhaps an experiment that carries very little weight. I think it does show, however, the necessity for being quite sure that the gloves you wear have no imperfections and that a very careful toilet of the hands be made before the gloves are put on, at least a five to 10 minute scrub.

I have recently had an industrial case, which, while it brings out nothing new in treatment, illustrates the use of the x-ray both as a diagnostic and therapeutic agent.

A young man, 19 years old, while riding on the running board of an automobile was hit by another auto and received a crushing injury to his leg. There was a compound fracture of the fibula, the calf muscles were badly lacerated and the skin and facia evulsed from the entire anterior surface of the lower third of the leg. I attempted a complete debidement, cutting away all muscle until there were bleeding and retraction. Dakin tubes were inserted and the exposed tendons covered with strips of vaselined gauze. Gas gangrene and tetanus antitoxins were given that night and repeated next morning. There was considerable shock and as the hemoglobin was around 70, blood transfusion was done. Cultures and smears made from the surface and from the tubes showed little or no infection, so on the third day the tubes were brought more superficial. No deep Dakinization was done, but considerable ½% Dakin used superficially, also, Azochloramid. The patient seemed to be doing fairly well, but not entirely satisfactorily—some temperature and rather rapid pulse. I had skiagram taken to check up on fractured fibula and discovered what I diagnosed as air bubbles. I showed this to the roentgenologist who agreed with me. I thought or imagined that I could get a slight deep crepitation. Did I have a gas bacillus infection or not? If I did, was the course modified by the two prophylactic injections. Immediately a therapeutic dose of gas gangrene antitoxin was given and x-ray treatments started. Whether or not the antitoxin and x-ray treatments were necessary, I do not know, but I can assure you that I was very happy to have the skiagram clear up and the patient improve.

Occupational Disease Sessions

Abstracts of Papers Presented at the Occupational Disease Sessions, Annual Midwest Safety Conference, May 12-13, 1937, Chicago, Illinois

THE 15th Annual Midwest Safety Conference, May 12-13, 1937, at Chicago, had two sessions on Occupational Diseases—the first on "Industrial Fumes, Vapors and Gases," Wednesday, May 12, and the second on "Industrial Dusts," Thursday morning, May 13.

Presiding at the first session was the HON. PETER J. ANGSTEN, Chairman of the Industrial Commission of the State of Illinois. Speakers and subjects were as follows:

"Metal Fume Poisoning and Its Prevention," by DR. R. R. SAYERS, Medical Office in Charge, Industrial Hygiene and Sanitation, U. S. Public Health Service, Washington D. C.

"Detecting the Presence of Toxic and Flammable Vapors and Gases," by WILLIAM P. YANT, Director of Research and Development, Mine Safety Appliances Company, Pittsburgh, Pennsylvania, and

"Electroplating Fumes and Vapors and Their Elimination," by DR. PETER B. RASTELLO, Medical Director, Ternstedt Division, General Motors Corporation, Detroit, Michigan.

At the second session O. E. MOUNT, Secretary and Assistant Treasurer, American Steel Foundries, and Chairman of The Workmen's Compensation and Health and Safety Committee of the Illinois Manufacturers Association, presided. The following presentations were given:

"What Industrial Dusts are Hazardous? Why?" by DR. E. G. MEITER, Director, Industrial Hygiene Laboratory, Employers Mutuals, Milwaukee, Wisconsin;

"The Engineer's Part in Eliminating Dust Hazards," by RALPH R. MEIGS, Foundry Safety Supervisor, Liberty Mutual Insurance Company, Boston, Massachusetts, and

"The Doctor's Part in Eliminating and Controlling Occupational Diseases and Hazards" by DR. C. O. SAPPINGTON, Consulting Industrial Hygienist, Chicago.

First Session

CHAIRMAN ANGSTEN presented a brief discussion concerning occupational disease coverage, mentioning the different types of coverage as followed in different states at the present time and also naming briefly the pending bills in the various states. In the State of Illinois there are some 600 classifications which will be affected as to occupations and industries by the present coverage. A number of these were named. One of the greatest problems in this type of work is adequate coverage. Some states have monopolistic insurance coverage, a few have independent funds, and others have in conjunction with the funds, what is called compulsory assignment. A compulsory assignment bill has recently been drawn in this state. Mr. Angsten briefly traced the evolution of compensation laws in this state since 1913. In concluding, he stated that it might be of interest to know that since October 1, 1936, 92 claims of non-fatal type have been filed and four fatal claims have been filed.

DR. R. R. SAYERS in discussing "Metal Fume Poisoning and Its Prevention," stated that this condition was recognized early in the literature, beginning about 1831. It was attributed to different types of metals, both heavy and light in the beginning. By fumes, we mean solid particles that flocculate; these particles are usually formed by vaporization and condensation; they vary in size from 0.2 to 1 micron and are composed mostly of oxides of metals. Sometimes the condition produced by inhaling such fumes is called "zinc chills." Such fumes are ordinarily found around melting processes, welding processes and metallizing. Welding processes are extensively used and in these high temperatures vaporize the metals — perhaps a reduction of temperature may help to control the hazard. In metalizing processes it may be possible to afford protection by putting articles in closed cabinets and heating the metal gradually—the metallizing gun may also be used with reducing flame. In considering the symptoms of metal fume fever, it should be kept in mind that this is a temporary condition, that most cases occur off of the job; there may be dryness of the throat; a chill followed by fever and increase in white cells. It is interesting to know that no pathology has been shown in the lungs except in the case of experimental animals, this being congestion and bronchopneumonia. The condition occurs mostly in new men and those who do not have an apparent immunity. The older men acquire some immunity and this is explained by the theory of protein sensitization and immunity. Metal fume fever is not a chronic condition but a recurring one. It is of short duration and is often confused with acute bronchitis and influenza. The treatment is bed rest, warmth, quiet, hot baths, and hot drinks. The important point is prevention by the control of fumes, by preventing their formation or by controlling them through proper local exhaust ventilation. Ventilation should be so arranged that the flow is past the man and toward the work. Closed process is the method of choice; next comes proper ventilation, and finally personal protection in which the fresh air mask is the best. There have been no respirators approved by the Bureau of Mines for this specific use.

In the discussion, information was desired on mercury poisoning and prevention. This occurs most frequently from vapors of mercury found in mining and refining the metal—in manufacturing products in which mercury is used, and also in laboratories; in hatters and hatters' fur cutters where the great amount of mercury poisoning has happened in the past. Mercury poisoning is not metal fume poisoning, but a chronic systemic

disease. The effects found industrially do not include the effects from taking mercury by mouth in suicidal intent.

Concerning figures for safe amounts of metals, concentrations will vary (30 milligrams per 10 cubic meters of air is a figure which has been quoted). Variation will occur accordingly to individuals and depends upon immunity of various individuals. The subject of concentration in regard to metal fume fever is not of practical importance.

In reference to lead burners in storage battery plants, the greatest hazard is in cleaning the lugs on the positive plate with peroxide.

WILLIAM P. YANT in discussing the subject "Detecting the Presence of Toxic and Flammable Vapors and Gases," mentioned that the subject was a trifle ambitious for brief discussion. In estimating gases, for example, a person must be used who knows his gases. Symptoms of tickling of the throat or headache may be caused by many things besides exposure to a gas. Odor is not really significant. In choosing a method, we must find one which is accurate for the specific purpose. Determinations of flammability, for instance, are not necessarily as accurate as those concerning toxicity. There are few specific methods available—they are mostly general, which however can be applied adequately if the conditions are known. After obtaining results, it is necessary to know how to apply them and to know the limits and the effects.

There are several different types of sampling —we have grab samples, large samples, and continuous samples. The sampling should represent typical conditions. The size and nature of the sample also bears a distinct relationship to the method. It should always be kept in mind that no determination is better than the sample.

The general diffusion of gases does not occur as much as formerly supposed. Density makes a considerable difference in the mixing and stratification of gases and temperature is another factor. Once stirred up, however, the contents of the air remain fairly well mixed. As an example of a heavy vapor which easily stratifies, gasoline may be mentioned.

In taking samples, the position at work and also different points at the tables or benches may make differences in concentration. Sampling in mines may be difficult because of stratification. Sampling may have to be done at times at inaccessible points, so that it is necessary to use non-absorbable tubes, according to the type of gas being sampled.

Important also to know is the reacting ability of gases, such as sulphur dioxide and hydrogen sulphide. Solubility and condensation are also important, the latter, for instance, may cause a loss of a certain amount of the sample. In short, the method of sampling must be sufficiently accurate and dependable, since life and property are involved.

In regard to specific methods, the nose is often used as an indicator; the difficulty is that olfactory fatigue may occur, but when going from fresh air into contaminated atmospheres, the nose may be of value in detecting odors. This of course does not include carbon monoxide and oxygen deficiency. In considering explosive ranges, of methane, ethane and acetylene and the like, the odor is not dependable. In general, odor is not a good means of detection except as an indication for further investigation.

Physical methods involve weight, fluidity, diffusion through plates, light refraction, light absorption, and others. Such methods are little used except in the case of the interferometer.

Of the chemical methods, the most common is volumetric analysis. Colorimetric methods are also considerably used. The principle of thermal conductivity is important—here the gases burn and the measurement of the amount of heat produced yields the results.

In physiological methods, in the measurement of oxygen deficiency, a lantern may often be lowered into a well where oxygen deficiency is suspected—there is a safe margin if the lantern continues to burn. The Davy lamp has also been used.

In combined gas methods, bombs may be used in which the amount of explosive gas is varied and a series of tests taken. Combined gas indicators use a platinum spiral wire and may also be used as continuous recorders.

There are many carbon monoxide detectors. At first the canary bird was used, but it was found that it was not so reliable. Subsequently hoolamite was developed. Palladium chloride is also used and the pyrotannic acid method has been developed for the estimation of carbon monoxide in blood samples. Carbon monoxide recorders are used with good effect in tunnels, providing automatic changes of ventilation.

We need satisfactory methods for the estimation of volatile solvent concentration and we also need the development of simple methods of immediate determination at the time of sampling. We have reached a new era of instrument development. The public now wants a device which can be plugged into an electric circuit, a button pushed and the results read immediately.

DR. PETER B. RASTELLO, in developing the subject "Electroplating Fumes and Vapors and Their Elimination," said that the physician was formerly devoted mainly to industrial accident work and made little inquiry into the health of industrial employees. The physician is now responsible for health relationships in industrial plants and must, therefore, be informed on changes in methods and materials. The medical department bears a strategic position in this respect, for it hears of complaints first.

In the preparation of metals for plating, various solvents, acids and alkalies are important.

Only two gases are liberated in electroplating processes, oxygen at the anode and hydrogen at the cathode—the amount is of no consequence, but a fine spray may be thrown in the air from the bath fluids by the liberation of these gases. The components of the bath are therefore important and must be known.

Degreasing processes are important because of the different types of solvents used. Xylene and trichlor-ethylene are most frequently encountered, the latter being somewhat habit-forming. A solution for this problem has been found by passing the parts through a closed chamber on a chain system.

In the use of hot caustic solutions, such processes may be more effective when a current is passed

through to produce gas for a scrubbing effect. Such tanks should be well exhausted.

In pickling processes, weak acids are ordinarily used. It is rare but may happen that hydrogen arsenide gas may be formed.

In brass dipping, the oxides of nitrogen may cause trouble; they are temporarily non-irritating, but serious later effects may be experienced.

It is the cyanogen compounds that we are the most concerned about; the possibility of difficulty may arise through the creation of cyanogen gas accidentally, or by the slopping or spilling of the solutions.

Atomization throws out vapors and should be the basis for proper exhausting. The amount of cyanogen gas ordinarily generated is negligible. In chrome plating, concentrated chromic acid and weak sulphuric acid are used and the exhaust of the tanks should be carefully planned and maintained. Chromic acid is not a poisonous substance, but does produce skin and mucous membrane lesions which are annoying, but not productive of disease.

Although air conditioning is on the way, it is necessary to perfect the present system until that condition becomes general. The influence of air currents in the diverting of vapors from exhaust systems must always be considered. The American Standards Association recommendations of applying exhaust six to eight inches above the liquid level and not more than three feet from the operator's breathing zone should be followed. Scientific methods are better than the unaided senses.

In our work we are very much interested in what is in the air and how much—not necessarily in what is removed. We have installed a collecting apparatus in our electroplating departments for the collection of air samples, during the working period. We make an especial study of the factors of fluctuation. We have a health hazard committee composed of safety men, physicians, maintenance men and chemists. To say it briefly, the safety man observes; the chemist determines; the doctor interprets; and the maintenance man eliminates.

We should be able to work out methods of controlling hazards; personal protective devices should be considered as emergency procedures. The coordination of the activities of the personnel is really a vital factor. Susceptible persons should be removed to other departments. Finally, we can make a definite contribution to the protection of employees by the proper use of these methods.

Second Session

DR. E. G. MEITER, in discussing "What Industrial Dusts are Hazardous and Why," stated that the importance of dust in industry has only recently been realized—that compensation laws and claims have emphasized the importance of this subject.

Industrial dusts are classified as (a) fibrosis-producing; (b) toxic or poisonous; and (c) nuisance dusts.

Of the fibrosis-producing dusts, only two cause disease, siliceous dust and asbestos dust, through inhalation in high concentrations over a period of years. Disability arises through intercurrent infection.

Free silica occurs in nature most commonly as quartz — other forms are tridymite, calcedony, opal, diatomaceous earth and tripoli. Dusts are harmful in direct proportion to their free silica content. We must differentiate between combined and free silica; the total silica as often reported is not significant. The only harmful silicate known is asbestos. Chemical analyses ordinarily do not give the free silica content and it is necessary to have these checked by petrographic analyses. Either cryalline or amphorous silica may produce injurious effects. Recent research has indicated that calcedony may be more rapid in its action than quartz. The characteristic effect of free silica is to produce scar tissue by physical and chemical processes, and not by hardness or abrasive action as formerly supposed Apparently free silica is a tissue poison.

The mixed dusts may be modified in their action by the kinds and amounts of other dusts than free silica that are present in the mixture. Gypsum and calcium salts appear to slow the action of silica. Similarly, in granite dusts, the presence of silicates modifies the action of the quartz contained in the granite dust. In foundry dust, which is another example of mixed dusts, we have quartz, clay, carbon, slag, ash, feldspar, silicates, and other materials, and the action of free silica is, therefore, modified.

As has been said, asbestos dust is clinically the only disease-producing silicate. It is composed of hydrous magnesium silicate and produces a fibrosis which is milder in its action than silicosis. Recent research at Saranac seems to indicate that other silicates are inert without the presence of infection.

Iron, coal, cement, gypsum and marble, as well as other dusts, of themselves do not produce injury except as caused by a fluctuation in the free silica content of such dusts.

Considering the toxic dusts which produce their effects by inhalation mainly, lead, manganese, arsenic, and mercury are important. In metal fume fever, which is sometimes called brass or zinc chills, a temporary reaction is produced; there are no known cumulative or permanent effects.

Nuisance dusts are uncomfortable, and are composed mainly of the organic dusts in general. These may cause irritation or discomfort, but do not interfere with pulmonary efficiency or susceptibility to tuberculosis. It is advisable, however, to reduce them to the lowest possible concentration and it is also desirable to reduce all massive dust concentrations to reasonable limits.

RALPH R. MEIGS, in presenting the subject "The Engineer's Part in Eliminating Dust Hazards," was not a professional optimist, but he believed that the engineer's job was fairly simple in locating, catching, and eliminating dust.

In attacking the problem, one finds a real engineering job which will cross traditional methods in the custom of carrying out certain plant processes and there may be considerable "backtracking" if the proper foundation is not laid. One should always know the types of dust concerned in the problem.

The interpretation of exposures is tricky because of the development of peaks and floods—the data must be critically analyzed and carefully related to the processes which were being carried out during the sampling.

The engineer can do a fairly good job by using his eyes, his nose, and perhaps a blue serge suit occasionally. The best job can be done in compliance with ventilation codes. One must not be fooled by visible appearances—it is hazardous to give an estimate of the amount of dustiness on visual inspection alone.

There are a number of principles which may be used—the substitution of harmless materials may solve the problem—the isolation of operations may be the answer.

Control of Hygienic Exposure

—*Practical Methods*—

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FOR the successful solution of any task or problem, certain information and knowledge are necessary.* Certain tools and equipment are needed, and quite often a certain amount of skill and technic come in handy. For example, a man is going fishing. He naturally is desirous of bringing home some fish. What, now, are some of the necessary prerequisites to insure his success? A number could be suggested. You say he should like to fish. He should know where the fish are. He will need some equipment in the way of tackle, bait, boots, boats, etc. He should know something of the kinds and habits of fish, what kind and size are permissible to catch and keep. He may need some sort of measuring stick. An understanding and cooperative co-fisherman may be desirable.

Likewise in launching a campaign for the control of industrial exposures, there are some prerequisites which are necessary for success, and others which are highly desirable:

1. One of the first things to know is what exposures exist in your plants, what is the nature and extent of the exposures, what has been done to control them, how successful is this control. In short, a complete survey of the plant is necessary. The use of the following form is suggested in making this survey:

SURVEY OF POSSIBLE OCCUPATIONAL HAZARDS

Dept.	Hazardous Operations	Nature of Exposure
No. of Workers Exposed	Method of Control	
Effectiveness of This Control		
Based on air analysis, etc.	Based on health study of those exposed.	
Recommendations of Improvement		

Such a survey not only gives you a complete picture of the condition of your plant, but also helps in determining the points against which your control campaign should be directed. It can also serve as a record.

2. The second necessary item is a physician or medical department with specific knowledge of the hazardousness of various toxic substances, dusts, etc., from a health standpoint, and also knowledge of the extent to which these exposures have affected and are affecting the health of the workers.

3. The third prerequisite is a plant engineering force that is interested in the problem and is well versed in the design, installation and maintainance of hoods, exhaust systems and other control mechanisms.

4. A fourth item which is desirable but not absolutely essential, is the necessary equipment for air sampling to determine dust concentration and air contamination. Such equipment is helpful in determining if control is necessary and to check the effectiveness of control used.

5. Another desirable factor is an interested, well-informed and cooperative plant supervisory force.

6. In view of the fact that the study and control of industrial exposures is of recent growth, it is often desirable to have one individual charged with this responsibility. He should be able to coordinate the efforts of the existing medical, engineering and plant supervisory forces.

General Methods of Control

THE over-all objective is, of course, to remove all exposures, or failing in this, to limit exposures to the point where there is no danger i.e., sub-threshold exposures.

Following is a list of the methods of control generally used in industry to accomplish these objectives:

1. Substitution of a safe material for the one causing the exposure, as the use of less toxic solvents for benzol and the use of steel shot for sand in cleaning.

2. Substitution of a safer process for the one causing the trouble, as wet grinding and drilling for dry grinding, and the use of a wet process in making and handling plates for storage batteries.

3. Preventing the escape of toxic substances and harmful dusts into the air used by the workers.

This is accomplished in two ways: First making the operation entirely automatic, thus eliminating the worker, and then enclosing the equipment so as to prevent the escape of harmful substances. Examples of this method are automatic sand blasters and painting by conveyor dipping or automatically controlled spray guns. Secondly, by power exhaust ventilation. This method is the most practical and most generally used for the removal of gases, fumes and dust when a worker is essential for the operation. A suitably designed hood is placed close to the source of the trouble and a suction fan draws the polluted air away to either the outside or to a filtering plant or dust collector.

4. The use of protective equipment by the worker, as goggles for eye protection from glare or flying particles, rubber gloves, boots or aprons from acids, oils, solvents, etc., respirators against dusts and gas masks against toxic gases and fumes.

5. The exercise of proper hygienic care on the part of the worker as proper washing and bathing by those who work in oil and observing certain health rules by lead workers.

6. Lowering the exposure. This is accomplished by the rotation of workers to less hazardous jobs or by shortening the working hours.

7. Selecting employees for hazardous exposures who are the least susceptible to those exposures. Those who are to be subjected to exposures from dust, fumes and gases should be free from respiratory difficulties. Lead workers should be free from ailments of the alimentary

* Read before Midwest Conference on Occupational Diseases, May 4, 1937, Detroit, Michigan.

tract. Those who are to work in oils, paints, etc., should be free from skin disorders.

Dusts

IN GENERAL these are two classes of dust to be considered:

1. Those capable of producing respiratory troubles, such as fibrosis of the lungs.

2. Those that may cause systemic poisoning as lead compounds, etc.

In those industries where many of their products are shaped from cast-iron (as is the case with Delco-Remy) the problem of exposures from the dust created by the machining of cast-iron, is an important one. While Dr. Sampson in his recent study of iron ore mining is of the opinion that ferrous oxide dust is not conducive to causing tuberculosis, one has in cast-iron machining, mixed with the iron dust, considerable silica dust which comes from the sand used in coreing and molding. And, of course, with silica there is the danger of silicosis with its attendant tuberculosis.

Previous to 1934, very little effort had been made by our Company in controlling the dust hazard in our cast-iron machining departments, and as a result work in these departments was considered as a dirty job. The workers were convinced in their own minds, and possibly logically so, that any respiratory difficulties which they had were either caused by or aggravated by the dust to which their work subjected them. Labor turnover was relatively high. Sufficient data is not available to determine whether there was any increase in the tuberculosis rate. The tendency to such an increase was offset by our practice of transferring men "out" based upon the recommendations of the medical department.

During the summer of 1934, the Metropolitan Life Insurance Company made a rather extensive survey of our plants. As a result of this survey and subsequent surveys by that insurance company and by ourselves, an extensive campaign of dust control has been carried out. On the original survey before any control methods were in use, the dust concentration in our cast-iron machining departments ranged from five to as high as 12 and 15 millions of particles per cubic foot of air. Since the installation of exhaust systems, these counts are now as low as one million and seldom in excess of two and one-half million particles per cubic foot of air. The jobs are now relatively clean, and there is little or no complaint on the part of the workers. In fact these departments are considered as very satisfactory places in which to work, and the requests for "transfers out" are few in number.

The most practical way for removing dust is to place a suitably designed hood around the source of the dust and by means of a suction fan draw the dust-laden air to either the outside or to a dust collector or filtering system.

In view of the fact that the installations of exhaust systems vary considerably with the different types of machines, they are difficult of description.

In general, in the design and installation of exhaust systems, several points should be kept in mind, namely:

1. A given velocity of air is required to carry dusts of a given density.

2. The area of the hood opening must be kept in such a proportion to the area of the pipe carrying the air away from the hood that the velocity of the air in the opening does not fall below the velocity required for moving the dust in question.

3. The hood surrounding the source of dust must be so designed and shaped as not to slow up or hinder the loading or unloading of the fixture on the part of the operator. Otherwise his tendency is to disregard the use of it.

4. The question of heat loss in cold weather must be considered if the dust-laden air is to be discharged to the outside. Such a consideration may make it advisable to run the air through a filtering device and then back to the plant.

Occasionally, owing to the possibly short life of the product or of the particular method of machining in use, the expenditure of money for an exhaust system is inadvisable from a financial point of view. In one such case in machining cast-iron, the dust count was reduced from around 15 million to well below five million particles per cubic foot of air by the simple expedient of removing all air hose and substituting brushes for cleaning off fixtures and by having the floor swept up after the regular force had gone home from the shift. If at all possible, holding fixtures should be so designed as to permit the chips and dust to fall free, and thus do away with the necessity of blowing them off with air which increases the dust in the air considerably.

You will find that the engineer engaged in designing and installing exhaust systems, having as he does, a type of mind which demands exactness, would be pleased if he had a definite figure for permissible dustiness. In this regard Drinker states that "the point has not been reached where a manufacturer can be told with certainty that his plant will have no silicosis if he keeps dustiness down to some definite figure."

The varying susceptibility of the employee, the period of exposure, the type of dust, the amount of free silica, the lack of uniformity in concentration are factors which make it difficult to set a figure of permissibility. One might also add the lack of definite data.

In South Africa where the dust is said to contain more than 85% free silica, a tentative standard of eight and one-half million particles per cubic foot has been set as the upper limit of dustiness to be regarded as allowable.

From the results of a study made by the Public Health Service in the granite cutting industries it was found practicable to suggest a tentative standard for the upper limit of allowable dustiness between 10 and 20 million particles per cubic foot of air for workers exposed to dust resulting from granite cutting. The same limit would presumably be applicable in the case of other dusts with the same physical characteristics, particularly with a silica content of 35%.

The Industrial Commission of Wisconsin reports as follows regarding the amount of dust to be allowed in the air breathed by workers:

The maximum silica-dust concentration considered permissible in the air breathed by a workman at any point in the normal breathing zone has not been definitely established. The commission, its advisory committee, employers and scientists have agreed on a tentative figure of 15 million countable dust particles under 10 microns

in longest dimension with free silica content of 35% in a cubic foot of air as determined by United States Public Health Service technic. Variations in free-silica content will make proportional inverse changes in this standard. In the case of practically pure silica the permissible dust count would be 5,250,000 countable particles.

Therefore, in order to give our plant engineering staff a goal toward which to work our Company has set up empirically a figure of five million particles per cubic foot as being the high range of permissibility. In view of the fact that all of our castings are made from permanent iron mould, and the only source of sand is from the sand cores, it is felt that this figure of five million is well on the safe side.

All of the discussion up to this point has had to do with dusts containing silica. It an average manufacturing plant there is usually a number of other dusts present which are not particularly harmful in that they are not fibrosis producing. However, in view of the fact that dust of any kind is disagreeable and that the average worker feels that "dust is dust" and that any respiratory irritation which he may experience is due to the dust on his job, and since the average practising family physician will usually concur with him in his belief, our Company has adopted the policy of controlling all dusts regardless of their nature.

Plating Hazards

SEVERAL years ago, our Company experienced considerable health difficulties in our plating, particularly chrome plating. Due to the extreme heaviness of chrome fumes the usual method of exhaust ventilation was inadequate. Our troubles continued until new chrome plating equipment was purchased wherein the control of fumes was an integral part of the equipment. By the present method, the heavy chrome fumes are pulled downward by suction through openings at the edges of the tank, to a container underneath, where a large portion of them condense. This air is then drawn through a vertical duct to a cylinder of approximately twice the diameter of the duct. This cylinder has a series of baffles which, assisted by the lowered velocity, entraps the remaining chrome and it is washed back to the container underneath the tank by a small stream of water. This chrome solution which thus collects is added to original chrome tank.

With this new system, an analysis of the air shows no trace of chrome and our health difficulties have vanished.

In zinc, copper, cadmium and nickel plating, theoretically at least, no gases other than oxygen and hydrogen are given off. However, actually, as the plating is speeded up, the plating solution become heated and some of the solution is carried off with the oxygen and hydrogen in the form of a mist. Thus with the advent of faster and more up to date plating methods, it has been necessary to cover the tanks and provide forced exhaust ventilation.

Lead

FOR the past nine years, our Company has been engaged in the manufacture of storage batteries. During that time no serious case of lead poisoning has occurred, and only occasionally has an employee had a slight touch of it.

In general our method of control is as follows:

1. Employ only those people who have been free from lead exposure in the past, and only those who are free from ailments of the digestive organs.
2. Isolate all operations which may give off lead dust from those that do not.
3. Keep the floors, paste machines and pasted plates wet at all times so as to prevent the giving off of dust.
4. Make regular analyses of the air for lead at the strategic points of exposure and endeavor by means of exhaust controls to hold the lead content of the air down to a safe point.
5. Physical examination of all lead exposed employees once a month, and at the slightest indication of leading, transfer to a job with little or no exposure.
6. Require the worker to wear a respirator in those few places where the lead concentration is above a safe point.
7. Insist on personal cleanliness and hygiene on the part of the worker.

Soldering

THROUGHOUT our plants, there are a number of soldering operations which are done by machine, by dipping or by using an electric solder iron. Most of these operations are provided with exhaust ventilators, not so much to prevent lead absorption, as to remove the smoke incident to the burning of the flux and insulation on the parts being soldered.

Bakelite

IN OUR bakelite departments, the bakelite powder is formed into a pill of appropriate size and shape for use in molding. These pill machines are entirely enclosed in a small room which is provided with exhaust ventilation.

Oils

THE control of skin disorders of employees working in oils has always been a difficult problem.

Many different approaches have been made by different concerns. In the past, our Company has tried a variety of measures. Our method of approach at present is as follows:

1. A central supply system from which oil is supplied to all plants. This system has a storage tank for new oil, a settling, filtering set-up for used oil.
2. Use of a protective hand ointment.
3. Program of cleanliness with proper wash room facilities provided.

With 400 operators working in oil, there has been only one minor case of so-called oil poisoning in the past year.

It is our belief that personal cleanliness is the greatest factor in control.

This completes the list of hygienic hazards with which our Company has had to deal. I realize that many of you have numerous other hazards that I have not discussed. The reason for not mentioning them is because we have had no experience with them.

In closing I would like to state that I believe any Company, with a certain amount of determination plus reasonable intelligence, can successfully control its plant hazards.

Occupational Dermatoses

—*and Their Relation to Compensability*—

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IN HIS work on Dermatogoses (occupational dermatoses) Prosser White[1] makes the opening introductory remark, quoting Dr. James, the translater of a treatise written in 1746: "Every sick person should be asked by his physician 'what trade is he of?' "*

This question is just as applicable today, perhaps even more than it was 200 years ago. Every occupation requiring the use of new chemical compounds adds to the number of those occupations already accredited with having a certain amount of hazard attached to them, especially in the field of occupational dermatoses. "Occupational" is here used to include the term "industrial", as all dermatoses falling in this group are by no means associated with industry, i.e., manufacture.

One has only to consider for a moment the staggering number of occupations which have been reported as productive of dermatitis to realize how limitless is this field of dermatology and also its tremendous importance.

In a recent report Weber[2] lists 588 occupations, from acetaldehyde workers to zincers; 792 substances used by workers which are capable of producing a dermatitis and 153 plants which may cause irritation of the skin.

In the light of these figures the wonder is not that so many develop dermatitis, but that so few do, especially when the skin irritants may belong to any or all of the three general divisions—chemical, bacterial or physical.

To arrive at an accurate estimation of the total number of cases of occupational dermatitis in one year would be a tremendous task, as there are undoubtedly many cases of this type which are never treated and never reported.

Lane,[3] of Boston, however, has made an estimate of 50,000 cases a year. Although the estimate was made 11 years ago, Lane thinks there has been no decrease in spite of all added precautions for prevention of dermatitis.

Prosser White believed there were 25,000 new cases yearly in England. From reports received from various states in this country it would seem that dermatitis has a high incidence in the production of compensable occupational diseases, a general average being about 64%.

So if industrial dermatitis is to become a compensable disease it will mean increased benefits for the employee, many difficulties for the employer, and endless disputes regarding the cause and nature of the dermatitis, especially with regard to the degree and duration of disability.

Sulzberger[4] has defined industrial dermatitis as "an inflammatory skin affection in which the pursuit of an industrial occupation can be shown to be a major eliciting factor."

This, he further states, is a sub-category of occupational dermatitis.

IT IS generally agreed among dermatologists and also by their patients who are sufferers from occupational dermatitis that these diseases should be compensable. That being taken for granted three questions then arise:

1. Should these occupational dermatoses be placed on the same basis as an injury and be classed accordingly as a compensable occupational disease?
2. Should the schedule of compensation differ from the schedule paid for other occupational disease?
3. How should occupational dermatoses be judged, and should the burden of proof be placed upon the employer or employee?

There are at present, according to statistics of the United States Department of Labor,[5] only 16 states which have laws providing for compensation in occupational disease, although in some of the other states the compensation laws are interpreted more liberally so as to include disease. The states so compensating for occupational disease are California, Connecticut, Illinois, Kentucky, Massachusetts, Minnesota, Missouri, Nebraska, New Jersey, New York, North Carolina, North Dakota, Ohio, Rhode Island, West Virginia and Wisconsin.

In framing laws covering occupational diseases one of three methods may be adopted: *first*, by naming the specific compensable diseases; *second*, by making a "blanket" law including all occupational diseases and, *third*, by changing the word "accident" in the law to "injury".

Six jurisdictions in the United States have a schedule of specific compensable occupational diseases. Ten jurisdictions have adopted the blanket provision method, while California, Wisconsin and Massachusetts use the word "injury".

In 1929 the International Association of Industrial Boards and Commissions adopted a resolution recommending the inclusion of all occupational injuries and disabilities in the compensation laws of the states and provinces affected. This was on the basis that blanket provisions would add not over 1% to the prevailing insurance cost.

Conferences of other groups have gone on record as favoring a "blanket" coverage type of compensation laws.

Twenty-one states require that occupational diseases shall be reported.

The schedules of compensable diseases of those states using such methods vary slightly, but are in general about the same.

Many other states have legislation pending regarding this important subject, and in Michigan there are several bills proposed providing for compensation.

House Bill No. 63 is for the purpose of "providing compensation for injury, occupational disease to or death of employee" and "establishing a Department of Labor and Industry". Compensation will not be paid unless the employee is disabled for at least one week, such compensation then to begin on the eighth day after the onset of incapacity. If, however, the incapacity continues six weeks or longer or if death ensues, compensation would be computed from the date of disability.

For 90 days the employer will furnish reasonable medical, surgical and hospital services, but one year is put as the limit of extension of such services. This bill evidently intends disability to be from any cause, as there is no provision in it for a schedule specifying causes and types of dermatitis which would be considered disabling or compensable.

* Presented at the Midwest Conference on Occupational Diseases, Detroit, Michigan, May 5, 1937.

House Bill No. 127 is also apparently as all inclusive as the preceding. It has removed the word "accidental" from the existing compensation law and inserted the word "disability."

It includes disability or disease proximately caused by and arising out of and in the course of the man's employment. It also removes the 90 days for medical treatment and provides unlimited medical treatment, both in compensation matters and in occupational disease cases.

No schedule of compensable occupational diseases or disabilities is included in this bill.

House Bill No. 192 provides compensation for disability or death resulting from *certain* occupational diseases, and it provides also for the establishing of a Workmen's Compensation Commission and a Medical Board on occupational diseases.

There is attached to this bill a schedule of diseases deemed to be occupational diseases. Only those of dermatologic interest are noted:

Anthrax.

Chrome ulceration.

Destruction of tissue by radium, other radioactive substances, or x-rays—epitheliomatous cancer or ulceration of the skin or of the corneal surface of the eye, due to tar, pitch, bitumen, mineral oil or paraffin or any compound, product or residue of any of these substances.

Glanders.

Infection from blisters due to the use of tools or appliances in the employment.

Infection or inflammation of the skin, eyes or other contact surfaces, due to oils, cutting compounds or lubricants, dust, liquids, fumes, gases or vapors.

Tularemia.

This bill grants to the employee all he could reasonably expect to receive; it protects industry against accrued liabilities prior to enactment of the act, and provides a gradually increasing rate of recovery for such occupational diseases as require considerable time to develop.

Senate Bill No. 106 would amend Act No. 10 of the Public Acts of the First Extra Session of 1912 and add a new section—part 7—which would contain all the provisions for compensability of occupational diseases.

"Disability" here means being prevented from earning full wages in the work at which the employee was last employed.

This bill provides a schedule of compensable diseases, 19 groups in all, of which only seven are of interest to dermatologists, the last one especially as it is "disability arising from frost-bite."

It would seem, therefore, that the choice of legislation lies between the "schedule" law or the "blanket" law and, if a dermatologist were allowed to express an opinion I believe that the "blanket" law would be too inclusive and open the door to innumerable claims without foundation.

As the development of this field of occupational dermatoses is entirely new in Michigan, it will require a great deal of thought and much revision of laws before adequate statutes can be evolved which will be just and fair to employer and employee alike.

MANY questions have arisen in the course of this discussion, and the following are only a few of the multitude which must be clearly understood before satisfactory laws can be framed.

In cases of occupational dermatitis should the burden of proof be placed upon the employee or the employer?

Since the employee is the one who is disabled and making the claim for compensation, it should be required of him to present a reasonable proof as to the cause of his disability. Otherwise the employer would often be imposed upon by malingerers who could induce a dermatitis which nobody could prove was *not* caused by his occupation.

The Illinois law states that "a disease shall be deemed to arise out of the employment, only if there is apparent to the rational mind upon consideration of all the circumstances, a direct causal connection between the conditions under which the work is performed and the occupational disease, and which can be seen to have followed as a natural incident of the work as a result of the exposure occasioned by the nature of the employment and which can be fairly traced to the employment as the proximate cause, and which does not come from a hazard to which workmen would have been equally exposed outside of the employment."

This interpretation would thus naturally exclude ringworm, ordinary infections, tuberculosis of the skin, and syphilis.

Should there be proof of knowledge of preceding dermatitis or sensitization in the same or other occupations before compensation is denied?

This argument might have justification in the case of an employee entering upon an occupation knowing himself to be sensitized to the materials to be used, but not making that fact known to his employer.

Certain sections of laws in some states provide for such a contingency in obliging a sensitized employee to engage in other occupation, provision also being made in that event for pay equalization.

TO WHAT extent can the patch tests be relied upon to prove the source of a dermatitis or to test the sensitivity of an employee's skin before starting a new occupation?

Dr. Sulzberger has taken up that phase of the subject and has given a very excellent exposition, but there is one thing that the patch test is not yet able to do and that is to reproduce exactly the working conditions in which the employee receives his dermatitis. (See INDUSTRIAL MEDICINE for May, 1937, p. 296.)

The use of the patch test is still in its infancy, and it may well be that employers in future will patch test their prospective employees to determine their degree of sensitivity to the materials used in their occupation and thus obtain a more definite idea regarding the availability of certain individuals for special departments.

Should an employee have the privilege of waiving his rights if he wishes to be employed in an occupation with known hazards?

This question might arise if a workman should insist on working in some specified occupation. In that event he should be allowed to work provided he knows the hazards and waives his privilege.

There are at present many types of dermatitis in workmen which did not originate from the occupation but which might be made to appear as if having arisen therefrom. The most frequent form is some variety of fungous infection. Even these are frequently claimed to be occupational and there

is no doubt that many occupations aggravate the condition or at least delay the cure.

Syphilitic lesions following trauma might also be included in some schedules as well as certain forms of tuberculosis of the skin—any or all of which might be the source of compensation claims.

Drug eruptions and factitial dermatitis are also encountered frequently enough to include them in the group of diseases which might easily be coincident to or aggravated by an occupation.

In questions as complicated as these the decision had much better be left to the judgment of a commission or advisory group about which there will be more later on.

IN REPLY to the question "What will be the cost of insurance to the employer in the event of passage of a bill for compensation in cases of occupational disease, including occupational dermatitis?" An insurance representative stated that it would be impossible to estimate the cost at present. It would appear from this that the estimated increase of 1% over the insurance cost in 1929 could not have been correct.

Also according to this representative the proper functioning and interpretation of a law of this description to be fair, honest and just to both employer and employee will depend upon the selection of a properly qualified Board or Commission who, in turn, will take the advice or recommendations of impartial dermatologists who will be qualified to pass judgment.

A bill of some description will undoubtedly be passed by the legislature of Michigan during this session, and we have been informed that whatever bill is passed will probably be based upon the principles stated in House Bill No. 192 to which reference has already been made.

There will undoubtedly be many instances in future in which a disease having no relation to occupation will induce the employee to claim compensation.

As an example of this a case might be cited briefly to illustrate that possibility.

Mr. A. H., a factory worker 30 years of age presented in 1935 a thickened, verrucous, mildly inflammatory lesion involving the dorsum of the right little finger and another lesion on the palmar surface of the same finger.

The lesion itself was frankly tuberculosis verrucosa cutis, substantiated by biopsy. Tuberculosis was also present in the patient's family and would undoubtedly have been discovered by roentgen examination of the chest at the time.

When first examined he was positive the lesion had been contracted as a result of his occupation, but he was finally convinced of the non-occupational nature of his dermatosis after a von Pirquet test was found to be positive, together with the positive biopsy. A year later he entered a tuberculosis sanitarium with well advanced pulmonary tuberculosis.

Osborne and Putnam[6] cite instances in which employees with syphilis received compensation under the New York laws. These syphilitic manifestations may be aggravated or precipitated by injury or irritation. They mention two cases of unilateral interstitial keratitis in congenital syphilitics; one case of interstitial keratitis in a person with acquired syphilis; one case of cardiovascular syphilis with aneuryism and aortic insufficiency; one case which developed early paresis after a minor scalp injury.

All these patients received varying amounts of compensation; and if the laws to be passed are too all-inclusive there will be no dermatosis from infantile eczema to senile atrophy which will not be claimed to be of occupational origin.

In Massachusetts, as stated by Downing[7], compensation is paid for aggravation by occupation of a non-industrial dermatosis, and it would therefore be a necessity for an employee to be carefully examined before being hired, in order to determine exactly the type and extent of any existing dermatosis, especially if the occupation could be considered such as could produce a dermatitis.

To quote Downing's concluding paragraph: "The justice of the decisions in all these cases depends on the impartiality of the commissioner and the presentation of the true facts by competent and honest counsel for each side. The number of industrial dermatoses hearings would be much fewer if these cases were seen early by a dermatologist trained in industrial work."

This expression of opinion has been heartily concurred in by several insurance agents with whom I have discussed this problem.

In the event of disputed compensation the Michigan Senate Bill 106 would provide for a commission to be appointed by an industrial accident board. This commission would be composed of three *qualified*, impartial physicians who would examine the employee and report. This report would be final. Compensation for services would be fixed by the board.

In cases requiring technical judgment, as do so many cases of occupational dermatitis, it would be no more than just and fair to the employee and employer to have at least two-thirds or all of such a commission *qualified* dermatologists.

It would be even more equitable if such a commission of qualified dermatologists could be made permanent. Then definite criteria for proof of claim could be established, such as whether a given dermatitis was due to the occupation in question, whether it was due to extrinsic factors, whether the disability was partial or total, how long disability should continue, whether other diseases obscured the clinical picture, etc., etc.

To the writer it would seem, owing to the infinite number of questions to be decided in the matter of compensability of occupational dermatoses, that the formation of such a commission would be absolutely necessary for the compensation law to function properly.

But, if such a commission is not impartial and should not be qualified, thousands of abuses of all descriptions could easily make the life of the employer unendurable.

We cannot enter into the question of insurance rates under proposed new legislation, but, in our opinion they would become prohibitive if the laws governing occupational dermatoses are not interpreted with all the wisdom of Solomon.

A representative of a company in contact with manufacturing firms recently stated as his belief that efficiency in the interpreting and administration of compensation laws must depend upon medical consultation of dermatologists with regard to occupational dermatoses.

As this is a new field there will undoubtedly be many errors committed, but these can be rectified,

and it is sincerely to be hoped that disability from occupational dermatitis will be made compensable and that whatever boards or commissions are formed to administer the law will rule fairly, justly and honestly for both employee and employer.

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The Industrial Breathing Zone

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ATMOSPHERIC discomfort and industry dust can, and will, be controlled.*

The atmospheric conditions that affect outside weather of course cannot be controlled, and consequently we will keep on talking about the weather on all occasions. Mark Twain's statement was "No one is doing anything about it." When we consider inside weather conditions, this is far from being correct in the world today.

Air conditioning is a subject widely discussed by all—which is very evident from Johnny's remarks when asked by his mother what theatre he was attending on Saturday afternoon. He replied "The Palace of course, it's air conditioned."

Air conditioning is not new, the physical laws which are used have been known for a long time. The effects of atmospheric humidity in connection with the manufacture of textiles and the drying of many substances have been known for more than 50 years. Various methods of adding moisture to air were developed in the textile industry and were used as needed to counteract atmospheric variations. In the field of drying the importance of suitable relative humidity has been known because of its very perceptible effect on the value of products. Originally, the control and mixing of dry heated air with humid air was by hand-operated dampers. The thermostat and hygrostat were then perfected, making it possible to provide automatic regulation. Progress in the art of air conditioning has therefore been a matter of developing and applying suitable mechanical equipment, but at least two companies have been furnishing complete air conditioning systems for a period of 30 years.

Owing to the general public's ignorance on this subject many unscrupulous concerns and individuals have been, and are, selling and installing, under the guise of air conditioning systems ordinary forced hot air systems which are anything but new and fall far short of what an informed person would demand.

While ventilation is generally defined as the process of supplying or removing air by natural or mechanical means to, or from any space, from the standpoint of comfort and health the problem is one of securing the necessary quantity of air, of the proper quality.

To quote the American Society of Heating and Ventilating Engineers' Guide, the term "Air Conditioning" in its broadest sense implies control of any or all of the physical or chemical qualities of air. More particularly it includes a simultaneous control of temperature, humidity, movement, and purity of the air. The term is broad enough however to embrace whatever other additional factors may be found desirable for maintaining the atmosphere of occupied spaces at a condition best suited to the physiological requirements of the human body.

Because of inherent individual variations and the sensation of warmth and comfort by persons exposed to identical conditions, no single comfort standards can be given which will meet every need. Factors such as the state of health, age, sex, clothing, etc., are all important, as they affect comfort standards. Where groups of people are gathered in a given enclosed space, the regulation and control of conditions must be based on the feelings of the average man or woman, and not to suit any particular one individual.

In the summer the common remark is "Oh, it's not the temperature, it's the humidity that gets me", while in the winter we are prone to explain that "It isn't the cold but the awful dampness." Our bodies are constantly giving off both heat and moisture, and consequently the air surrounding our bodies must be capable of carrying off such heat and moisture at the rate at which it is generated. For example, if the air is too cold and too dry, we are not comfortable as we lose heat and moisture too rapidly. If the air is too warm and too humid, we lose heat and moisture too slowly. In either case, we are not comfortable. The physical properties of the air which control its capacity for absorbing our waste heat, are temperature and relative humidity, in combination with air motion. Temperature, of course, we all understand, but relative humidity is generally not very well understood. A very simple definition is the amount of moisture contained in the air at a given temperature compared to the amount of moisture which the air would contain were it saturated. The warmer the air becomes, the more moisture it is capable of holding. Heating air, therefore, without adding moisture makes it relatively dry, or in other words, lowers the relative humidity.

Stagnant air may be depressing though it is pure. Air motion is very important as it removes the tropical air surrounding our bodies by replacement. Tests prove that a desirable air motion during the heating season is between 15 and 25 feet per minute, with satisfactory room conditions. In the summer time as temperatures are higher, the velocities may be increased to as high as 40 feet per minute with a dry bulb temperature of 80°.

It is possible to obtain air movement by natural means by having windows and doors open, but variations due to both changes in wind direction and velocities as well as air cleanliness generally make natural ventilation very unsatisfactory. The control of air movement and air conditions must

* Presented at the Midwest Conference on Occupational Diseases, Detroit, Michigan, May 4, 1937.

be positive, and therefore a mechanical system is required.

Air in motion whether it be outside or recirculated inside air picks up and carries with it dust, gases, odors, etc., and ashes from the combustion of fuel, particles of earth, lint, pollen, etc. To provide the best comfort and health conditions it is necessary that this air be cleaned either by some type of filter or air washer.

AS industrial physicians or engineers you are particularly interested in air conditioning and control of dust as they apply to industrial problems. With the passing of legislation with reference to occupational diseases in additional states each year, this subject will demand more and more attention from men interested in industry, so that steps are taken to improve industrial air conditions. Necessarily, the processes in some industries are such as to produce dust and even though these dusts are not always hazardous, it is good policy to give workers adequate protection from personal exposure in the interest of improved morale and employment standards. In addition to this value, there is also the economic value in decreasing the maintenance cost and increasing the life of equipment.

Life is just one new problem after another. Every change that is made usually requires some other change. In taller buildings air pressures due to the stack effect change ventilation requirements and the higher air pressures must be counteracted. Increase in the floor area with extension of the space boundaries of buildings has made it necessary to use more artificial lighting. The continuously increasing occupancy per square foot of floor space introduces a new problem. Increase in the rate of production of material per square foot of floor space within present buildings and higher ratios of production to floor area used in new factories must be given consideration. Increase in the sizes of producing units, changes of the methods used in manufacture such as conveying systems, automatic foundry shakeouts, reclaiming systems, cleaning and product classification systems, use of compressed air creating local disturbances, all must receive more attention.

During the last 10-year period there have been so many and such rapid changes in manufacturing methods that it has been physically impossible to solve the many problems which have come up. The improvement in conditions has not kept pace with production.

When extremely important problems are called to the public's attention, the natural reaction is to want a 100% cure immediately. Based on our past experience from a practical standpoint we all know that our efforts in the solution of the problems will of necessity fall short of the goal.

An inspection of the industrial section of any city will reveal manufacturing plants using old worn out frame or brick buildings, and new buildings of corrugated iron or other similar materials which are not suitable for maintaining the air conditions which should be required in such buildings. For example, moisture should be added to the air in most cases, but if the building offers little protection from the outdoors, this becomes a very difficult problem. If the building has a wooden roof moisture that will be condensed out is absorbed by the inner surface of the roof, consequently the wood will rot, and within a short time the owner will be required to make repairs. Proper thought must be given to building construction. This is very clearly illustrated by the publicity now being given to the building of homes so that new homes are constructed and old ones changed in order that air conditioning equipment can be installed.

With the proper building enclosure the reduction in air hazards is largely a problem of ventilation and dust control and not one of dust collection. While certain standards are being set up for breathing conditions, there are a large number of variables which must be considered, making it necessary that each problem be given careful analysis. The general nature of occupational diseases is such that action is slow, and often it is very difficult to determine the exact cause. Investigations have shown that with dust of harmful nature, long periods of exposure, and high dust concentrations must be avoided.

In a true sense ventilation is a matter of dilution, it consists of supplying air and exhausting air, gases, dust, etc., to or from any definite space preferably by mechanical means in order to provide and maintain a satisfactory condition of the air. What we should strive for is to duplicate an atmospheric condition which we have out of doors on an ideal June day, for "what is so rare as a day in June?"

IN PROVIDING ventilation the best solution seems to be a combination system of controlled air supply and exhaust which provides properly conditioned pure fresh air for the supply, and positive air removal exhausting the harmful and objectionable vapors, dust, etc. While general ventilation is often satisfactory for the maintaining of air motion, temperature, and humidity conditions, it s not suitable for the control of dust hazards.

Dust particles may be disbursed through movements transmitted to the dust bearing air, by the motion used in the process itself, by the motion of the machine and by external air currents. This can best be controlled by eliminating or reducing the air movement incidental to the operation. Where this is not possible the use of properly designed exhaust hoods is essential. In many cases this may require an experimental study following the procedure of designing, installing, testing, and rebuilding hoods to suit specific locations. This not only will produce a more effective system but will also generally reduce the cost of operation to a large extent.

Proper consideration of dust control by the designer and manufacturer of processing equipment will aid very materially. A piece of equipment is made to obtain certain results or a definite product and the functions of this machine should be thoroughly understood by the producer of the equipment and consequently he is in a position to have or obtain complete knowledge by enlisting the services of a dust control engineer in order that necessary provisions can be made in the machine for the control of the dust hazard. Suitable enclosures, hoods, etc., which do not interfere with the operation of the machine, can be made an integral part of the machine so that the dust and gases are removed at the source.

Where hoods are utilized they should be so lo-

cated as to make use of any motion imparted to the dust particles. Although it is desirable in every case to use exhaust air, in many unusual cases a supply may be desirable in order to direct the dust or gases into the exhaust opening. The most important factor is getting the dust or vapor into the exhaust opening.

Many state codes provide for a definite negative pressure or suction on various kinds of hoods but an analysis of the problem will indicate that even though the pressures specified are maintained it is not an assurance that the system will be effective. Entrance characteristics of the hoods influence results and the velocity and the total volume removed at a particular point, govern the efficiency in each case. The size of the hood to cover a particular machine or operation does not necessarily fix the volume of air to be exhausted. The particular problem may require double hoods, drop curtains, air blankets or screen, or the use of a directed air supply.

Due to the nature of the process it is often impossible to properly hood the equipment and in such cases the machine should be segregated from the main plant in a suitable enclosure and the incoming air so directed as to provide satisfactory air in the breathing zone adjacent to the individuals required, for carrying on the process. The breathing zone would be a zone of reasonable dimensions, the boundaries of which would be wholly without the space occupied by the operator's head, during all positions he might be in during the carrying on of his work.

One of the functions of hoods and exhaust ventilation is to remove dust. Consequently the understanding of what constitutes dust and what constitutes the dust hazard is important. Medical research has indicated that dust particles found in the lungs vary in size from approximately two to 10 microns. This is due to the fact that the path of the larger particles is affected by gravity more than by the air currents. Any of the larger particles that enter the individual's nostrils or mouth, generally are removed before they could enter the lungs. Of course in order that our natural filter functions properly temperature and moisture conditions of the air must be correct as dry air will dry up the moisture in the nostrils and the human filter will cease to be as effective.

In the discussion of dust or dust particles the engineer when asked for a definition immediately replies: The longest dimension of a dust particle one micron in size would be .001 of a millimeter, or one twenty-five-thousandth of an inch. Such a definition does not mean very much to most of us. Possibly the following comparison might be of value. The ordinary fly screen is generally about No. 14 mesh, and the side of the square opening varies from .04 to .05 of an inch. Each opening would pass a particle 1200 microns in diameter. For further comparison on the average, the greater percentage of the grains of granulated sugar will rest on a 60-mesh screen. The size of the opening of this screen is .00234 in. square, so the average diameter of these particles of sugar would be 250 microns. Thus the diameter of the ordinary grain of sugar is 25 times the largest dimension of dust particles which have been found in the human lungs. Considering particle size on a volumetric basis the cubical contents of the average grain of sugar, may be 16,000 times that of the largest dust particles retained by the lungs, and might even be two million times that of the smaller dust particles. This should indicate and make us realize that visual observation cannot be used as a measurement for the determination of harmful dust particles.

Various equipment for the determination of particle size and obtaining dust count is available. A previous paper on this subject gave you a complete picture of what can and should be done. The idea has often been advanced that all dust is harmful to the respiratory system. This of course is not true, as everyone inhales a great deal of dust yet most of us feel no harmful effects. It is important, however, further and again to emphasize the fact that dust content sampling tests should be made by individuals who have had sufficient experience and who use a recognized technique. And a geologist should determine the substance of the dust particles before stating whether they are considered as harmful material.

THE three items for consideration should be prevention, education, and cooperation. A plan of careful medical examination at the time of employment is desirable in all industries. The class of work the individual will be called upon to do should be considered at the time, and definite time set for further future examinations, the frequency of examinations to be governed by class of work. It is suggested that a definite educational program be followed. All employees should be properly acquainted with the hazard connected with the work they are doing. The importance of using equipment which has been provided for them should be emphasized, so that they will exercise every care in the performance of their regular duties. The success of educational programs on industrial accident prevention is a very good example of what can be done. An inspection of equipment which has been used for some time will often show that system is no longer effective. Branch pipes may have been removed, intake openings have possibly been closed, and sometimes additional openings have been added to an overtaxed system. A system should be balanced, and the continual operation is necessary to provide the proper control.

Regular housecleaning is necessary. Dust not removed by exhaust systems which deposits on beams, roof trusses, etc., should be removed, so that vibrations, air currents, etc., will not distribute it.

Cooperation coupled with the intelligent installation and use of equipment which makes possible the definite control of air currents and conditions should demonstrate to both labor and management that time and money spent in industrial dust control are warranted, and that preventive equipment warrants the same attention and care that are given to production equipment.

Any new industry or extension of an old industry in order to provide the most satisfactory working conditions should have in consultation together, the following: architect, structural engineer, heating and ventilating engineer, sanitary engineer, electrical engineer, illumination engineer, insulation engineer, dust control engineer, process or chemical engineer, and manufacturing or equipment engineer. Having definitely deter-

mined the requirements and provided accordingly, a competent inspector should be employed so that proper records are kept and that equipment will be used and kept in operating condition. All inspector's reports should be made direct to the management.

In conclusion may I quote from an article in the November, 1934, issue of *Factory Management and Maintenance*, by Mr. Leonard Church:

"The cost of a suitable dust system is never high if it is, first, properly engineered; second, considered in the light of the benefits to be derived. These benefits are manifold but cannot always be expressed in dollars and cents.

"They may consist of one or more or all of the following:

1. Reduction in accident hazard.
2. Reduced labor turnover.
3. Greater efficiency of employees resulting in reduced production cost.
4. Reduction in wear and tear on machinery, particularly where dusts of an abrasive nature are involved.
5. The saving of large quantities of a product, when the dust collected is the finest part of the product and has in many instances the greatest value.
6. Reduction in labor by the elimination of sweeping and cleaning.
7. Elimination of danger to health of employees.
8. Elimination of a nuisance to the industrial establishment itself as well as to its neighbors.
9. The esthetic value of a clean plant.
10. Prima facie evidence that the employer is using every reasonable measure to protect the health of his workmen, therefore providing a defense against the legal depredations of the dust racketeer or ambulance-chasing lawyer."

Compensation for Occupational Diseases

JAMES A. BRITTON, M.D.,
Chicago

WHAT is said in this paper about occupational disease compensation is not new.* Many others have thought or written the same thing. Two recent reports cover this subject very well.

The first of these is Bulletin No. 625 by the Bureau of Labor Statistics on "Occupational Disease Legislation in the United States, 1936." The second is the report on the "Problem of Compensation of Occupational Diseases," by the Committee on Standard Practices of which Henry H. Kessler was chairman. This last report is entitled "Objectives of Workmen's Compensation for Occupational Diseases," and was published in the 1936-1937 year book of the American Public Health Association. These two reports cover adequately both the state laws which have been already adopted and the intent of these laws. The purpose of the present paper then is not to reiterate what has already been so well stated, but to emphasize some of those things which are fundamental to any occupational disease compensation plan.

In considering this subject in its broader aspects it must not be forgotten that irrespective of our feeling in the matter this is an industrial age and the trend is decidedly toward more, rather than less, industrialization. This means that most industrial processes which have been generally satisfactory will be continued and that new processes will be used in increasing numbers. Because this is true the problem of occupational disease will continue, not only because of old and fairly well understood exposures, but also because of new and unstudied conditions.

We have been through a period when the relation of health and occupation received no attention.

Then came the time when every one seemed to have the "occupational disease jitters." We have now reached a time when workers, employers and the public recognize that there is such a thing as disability due to occupational disease; that such disability is a legitimate charge against the cost of production; and that there are simple and sensible procedures by which the injured workman can be compensated. Those comprehensive legal plans which have already been set up to handle compensation for occupational disease should be expected to be adequate and satisfactory for any new phases of the problem, providing the present handicaps are removed.

We have all thought of the more or less uniform plan in this country of compensation for industrial accidents, and have all observed the generally satisfactory operation of this plan. We have conceived a plan for occupational disease compensation largely patterned after the plan for accidental injuries, but we must not make the mistake of thinking that from now on all will be smooth sailing.

IN THE case of an accidental injury the man himself knows when, how and where he was hurt. He can usually see the extent and severity of his injury.

Most experienced doctors can estimate fairly accurately the period of temporary disability and determine whether or not there is permanent disability of any degree and if so, how much. A plant engineer or a safety expert may know exactly how to prevent such an injury occurring again. When we come to consider occupational disease, the problem ceases to be a simple one. The when, and the how, and the where of the disease may be very difficult to specify. The disease may not be easy for the most experienced physician to diagnose. He may not be able to determine disability or, if there is evident temporary disability, when the disability ceases. Even in a case of bona fide occupational disease it frequently happens that neither the doctor, the plant engineer nor any one else knows exactly how to control the hazard or prevent exposure of other workmen.

If we grant that the theory of the law to provide for compensation for occupational disease is fundamentally right and that the best way to carry out the provisions of the law is through a regularly constituted industrial board there is still a long way to go, because of the limited knowledge of such disease, until board decisions can be more than a matter of opinion. There seems to be but one answer—more knowledge of occupational disease.

* Read at the Twenty-Second Annual Meeting of the American Association of Industrial Physicians and Surgeons, Detroit, May 6, 1937.

The needed knowledge comes under two general heads—medical and engineering.

Some of these problems are national, but most of them are local. Generally speaking, each state, and more often each industrial community, must and will investigate and decide on the merits of individual claims for compensation. It will be possible, I think, for a local industrial board to become familiar with what is generally known about a given occupational disease, but when it comes to applying this general knowledge to a specific case the board will usually have to depend on local talent. Generally speaking, unless these local physicians increase their knowledge of occupational disease they cannot be of much help.

We already have, or will soon have, what we believe to be a fair legal plan for occupational disease compensation in most of our industrial states. The operation of this plan depends fundamentally on medical knowledge. At the present time anything like a fair knowledge of this subject is limited to a comparatively few widely scattered doctors. As stated before, the practical every-day application of this compensation plan must depend on the help of local community physicians. From all this it seems evident that industrial communities must have physicians with more than casual knowledge of occupational disease. To my mind this need is urgent and must be met.

Few of the "A" medical schools in the United States have any plan for teaching undergraduates about the effects of occupation. Seldom does any intern in any hospital have a chance to see or study cases that are definitely occupational in origin. Since this is an industrial age and a large part of our population is directly or indirectly dependent on industry, and since both industry and the community are faced with a serious medical problem, the least we should expect of our medical schools and hospitals is that they shall consider their part in the solution of this problem as of major importance.

It may be supposed that those physicians who have had considerable experience in furnishing medical service to industrial employees would have little difficulty in the field of occupational disease and that such men would be available at least for advice to industrial boards, but this is true only in a very limited sense. Usually such a man is familiar with a particular hazard that is common to his particular industry, but some hazard not ordinarily found in his industry is nearly as difficult for him as for any other physician without his industrial experience.

Engineering knowledge in the field of occupational disease is also limited. Exactly how to prevent dangerous exposure to a harmful substance is not usually known. Even the practical application of fairly well standardized engineering methods in a common problem such as dust removal is not generally understood. Control of an occupational hazard presupposes knowledge that there is a hazard and how the offending material affects the body. In a given exposure to some toxic substance where complete removal is practically impossible, the engineer wants to know what are the safe limits and how does he know when these limits are reached? Just a few little bits of knowledge like this sound insignificant, but in reality they mean the difference between a hazard and safety.

An industrial board must have available in every case where there is a claim for compensation for disability due to occupational disease, the evidence (1) that there was an exposure—when, where and how; (2) that there is an occupational disease and how it is diagnosed; (3) that there is disability; (4) that the disease is or is not curable; and (5) that the disability is temporary or permanent. How can a board get this knowledge unless their physician and engineer advisers can answer these questions? Of course we, or at least some of us, are able to diagnose lead poison positively when there is acute colic or wrist drop and plenty of stippled cells. We are sometimes sure of a disabling silicosis when the man is not too old and does not have too many things complicating the picture, such as myocarditis, nephritis or an obstructing prostate. At this Conference you have heard about solvents and their effects. How many of us—indeed how many physicians in the whole United States—are competent to pass on the deleterious effects of many of the solvents that are not commonly used in all parts of the country? How many plant engineers have any special training or experience in eliminating effectively any health hazards, even the common ones? I could amplify this subject at considerable length, but the point is that there are not enough doctors and plant engineers with training and experience in this field to serve this great industrial country.

I have spoken of the medical schools and hospitals with their students and interns. The community, the medical profession, the problem of compensation for disability due to diseases of occupation demand more than just preliminary training of young doctors. A much more comprehensive plan for the education and special clinical training of physicians already in industrial medical service must be developed. Conferences like the one we are having now are fine for the exchange of ideas, but we must do something more than talk about it. Clinical opportunities and clinical experience are what we need. There must be facilities where cases of known or suspected occupational disease can be seen, examined, studied, so that when we see such a case again we can be sure we have something more than a guess to contribute.

Of course the United States departments and some of our universities are doing just this thing now, but every medical school should have undergraduate instruction in the hazards and diseases of occupation, every university should have its occupational disease research department in both medicine and engineering.

The Bureau of Labor Statistics Bulletin tells us that there are now laws providing compensation for occupational disease in 16 states, Hawaii, Puerto Rico and the Philippine Islands. Several other states have similar laws under consideration at the present time. Some of these laws cover only a limited number of such diseases, others are all-inclusive and intended to be broad and comprehensive in every particular. There is no question about the trend of public opinion. The job of devising and applying a plan for giving adequate and just compensation for disability or death due to occupational exposure has been well started. There is still much to be done to make the operation of these laws generally satisfactory. As I see it, the big job will fall on the medical and engineering professions.

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"Changing Era!"

AN ERA is defined as "a period of time marked by a new order of things." Thus the era has two dimensions: length — which is relatively unimportant, and change—which is the measure of its historical significance.

As Dr. Greene's article (p. 368) implies in its title, and discloses in its substance, we are, indeed, in the very midst of an era. Our "period" is prolific of changes; seethes with their symptoms, stirs with their effects. The intellect, which hasn't yet discovered all that it knows exists to be discovered, is restless, unsatisfied. The emotions, which can sense but cannot yet define the elements that will, for all time to come, identify the distinction of these times, are bubbling with the heat of their anxiety. And the body politic has strange fevers, and the body economic itches with queer infections—while the modern Cicero exclaims: "O tempora, O mores!" A new order is in the making.

What is it to be? What shall history say of it a century hence?

There is some satisfaction, and possibly a hint of the ensuing permanence, in analysis, diagnosis. The complete and thoughtful examination recognizes the symptoms for what they are, and eventually calms the trepidation excited by their obvious persistence. Most of the symptoms are the phenomena of the slow—the painfully slow—evolution of human nature toward its far-off ultimate best—an evolution forever beset with the age-old manifestations of human nature at its worst. For when, in all of history, in any era, was there not the bitter and costly struggle caused by individuals, or groups of individuals, endeavoring to impress their will upon all people? Take that away from the present scene, or stand beyond the reach of its publicity, and the real significance of this era can be better observed.

For it will be realized, from that vantage point, that the light in the laboratory is brightly aglow with the illumination of great discoveries.

That in itself is the answer to all doubt concerning the importance of these years. Comforts and conveniences evolve, diseases yield, values accentuate and infinity is shorn of its mysteries—in the laboratory. Science is at work—science, which comes from "I know" and has no tolerance for "I feel" or "I believe." And widely at work, and intensively, and successfully, so that the body of knowledge is growing. And as it grows, as the proofs of things old increase, and the mass of things new rolls up its avalanche, the conglomerate of superstition and ignorance and emotion is on its way to being overwhelmed in reason. For ultimately, sometime, somehow, the laboratory which keeps on evolving new things for new ways of human living will produce the means of new thoughts for new ways of human thinking. Eventually it will pierce the hard reluctance of human ignorance. Eventually, indeed, it will even raise the level of human intelligence.

THINKING upon these things, therefore, we are not too greatly disturbed; the parades in the street and the shoutings in the lobby excite us not at all. We are confident of our era in spite of its "excursions and alarums."

It will command respect for its science, not for its politics; the history being written in its laboratories will be read long after the headlines of its infantile antics shall have passed into the limbo of things to be remembered with a laugh. For what else shall we say of some of our most obvious symptoms? Our seven-year headache? Result of an unbalanced diet theretofore. Our present political indigestion? It will eventually be ended by the ipecac of too much "must." Our plague of group and minority agitations, crusades, social panaceas, etc., etc? More or less the croakings of small frogs who find it easy to be "big" in the little puddles of their own micturition.

And it will command respect for its "medicine," for medicine makes its own eras, and while changes of whatever kind are in the making, keeps its own feet on the ground. Witness its refusal, through the decision of its leading organization, the A. M. A., to be stampeded into any official cognizance of the politics of the so-called "health insurance," while holding itself ready at all times and to the full extent of its facilities to give aid and information in the *science* of medicine, and, therefore, in the *science* of health. What a wise decision! And what a wealth the medical profession has of science, and what incalculable treasures its scientists are piling up and making available—the new insulin, sulfanilamide, fever therapy, new instruments, new techniques, and, above all, new appreciation of the fact that the medical profession, with all its progress through the eras of the past, has yet no limit upon its progress in the future.

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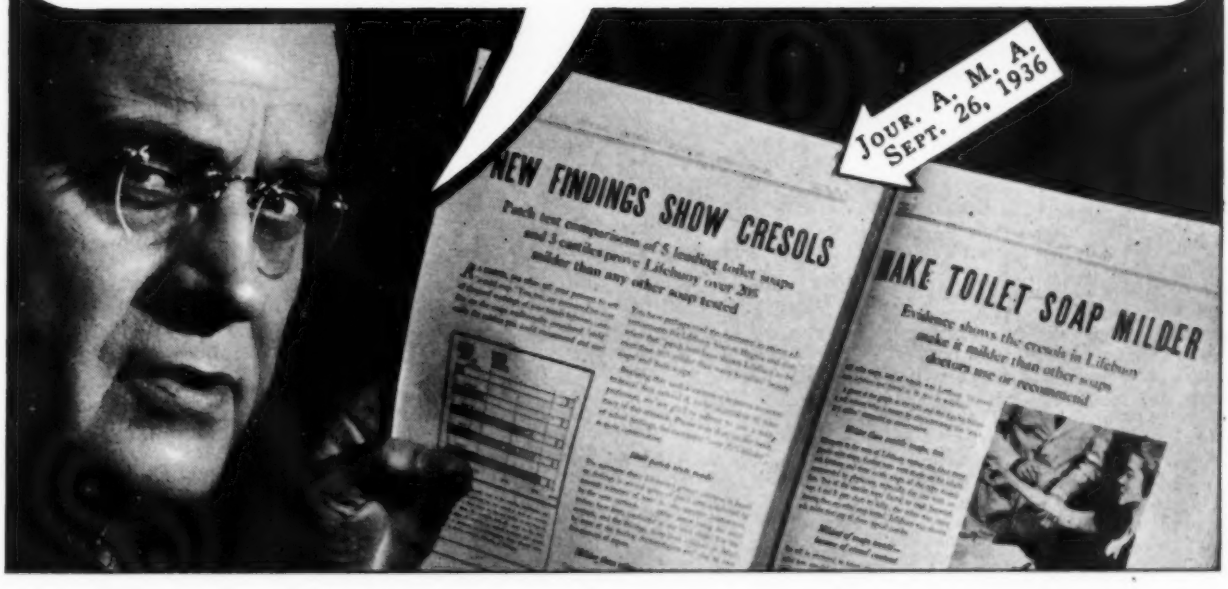

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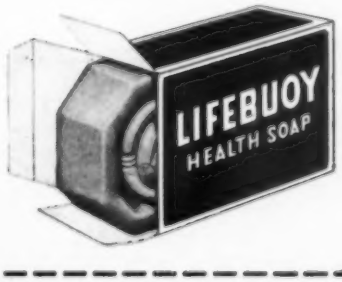

Occupational Diseases and Industrial Surgery

Silicosis Added to List of Occupational Diseases Compensable in Ohio

SILICOSIS is added to the list of occupational diseases compensable under the Ohio Workmen's Compensation Act through the enactment of a measure, Substitute House Bill 71, by the Ninety-Second General Assembly and which will become a part of the Workmen's Compensation Act on or about August 1, 1937.

Silicosis as defined in the act is: "A disease of the lungs caused by breathing silica dust (silicon dioxide), producing fibrous nodules, distributed through the lungs and demonstrated by x-ray examination or by autopsy".

The proposal was an agreed measure on the part of organizations representing labor and industry.

Pertinent provisions of the act are as follows:

1. An employee or his dependents will not be entitled to compensation, medical treatment or funeral expenses unless the employee has been subject to injurious exposure to silica dust in his employment in Ohio preceding his disablement for periods amounting in all to at least five years, some portion of which shall have been after the effective date of the act.

2. Compensation, medical, hospital and nursing expenses will be payable only in the event of temporary total disability, permanent total disability, or death, and only in the event of such disability or death resulting within one year after the last injurious exposure.

3. In the event of death following continuous total disability commencing within two years after the last injurious exposure, the existing requirement of death within two years after the last injurious exposure will not apply.

4. Maximum compensation awards will apply in cases where an employee has been subject to injurious exposure to silica dust in his employment in Ohio for periods amounting in all to at least five years after the effective date of the act. In event such exposure, after the act takes effect, amounts to less than five years, the maximum aggregate amount payable for disability, death, or disability and death, shall not exceed the sum of $500, plus $50 for each calendar month which may elapse after the effective date of the act and before the month in which disability began. The total amount payable in this latter type of cases shall not exceed $3,000.

5. Claims for compensation on account of silicosis will be forever barred unless application is made to the State Industrial Commission within one year after total disability began or within six months after death.

6. An employee or his dependents will not be entitled to compensation, medical, hospital and nursing expenses, etc., in the event of the failure or omission on the part of the employee to state, when seeking employment, the place, duration and nature of previous employment in answer to an inquiry made by the employer.

7. The State Industrial Commission is empowered to appoint three referees to be known as "silicosis referees" who must be licensed physicians in good professional standing and who have by special duty, or experience, or both, acquired special knowledge of pulmonary diseases. At least one of whom must be a roentgenologist.

8. Before awarding compensation for disability or death due to silicosis, the Commission must refer the claim to the silicosis referees for examination and recommendation with regard to the diagnosis, the extent of disability and other medical questions involved.

9. An employee filing a silicosis claim must submit to examinations—clinical and x-ray—ordered by the Commission.

10. The Commission may designate a physician, a pathologist, or such other specialist as may be deemed necessary to make an autopsy examination and tests to determine the cause of death and certify written findings to the silicosis referee.

11. If an employee refuses to submit to examinations after notice from the Commission or a claimant for compensation for death due to silicosis fails to produce necessary consents and permits after notice from the Commission so that an autopsy and tests may be performed, all rights for compensation will be forfeited.

12. Reasonable compensation of the silicosis referees and of other physicians used and the expenses of examination and tests will be paid, if the claim is allowed, as part of the expenses of the claim; otherwise from the surplus fund of the Commission.

The act amends Section 1465-68a of the Workmen's Compensation Act which provides for the compensation of employees disabled because of an occupational disease and lists the various occupational diseases which are compensable.

The proposal was introduced by State Representative Michael V. DiSalle, Toledo.

Following is a complete schedule of compensable occupational diseases, with a description of the process involved:

1. ANTHRAX — Handling of wool, hair, bristles, hides and skins.

2. GLANDERS—Care of any equine animal suffering from glanders; handling carcass of such animal.

3. LEAD POISONING—Any industrial process involving the use of lead or its preparation or compounds.

4. MERCURY POISONING—Any industrial process involving the use of mercury or its preparations or compounds.

5. PHOSPHOROUS POISONING — Any industrial process involving the use of phosphorus, or its preparations of compounds.

6. ARSENIC POISONING—Any industrial process involving the use of arsenic or its preparations or compounds.

7. POISONING BY BENZOL OR BY NITRO AND ADIMO-DERIVATIVES OF BENZOL (DINITRO - BENZOL, AMILIN AND OTHERS)—Any industrial process involving the use of benzol or nitro—or amido—derivative of benzol or its preparations or compounds.

8. POISONING BY GASOLINE, BENZINE, NAPHTHA, OR OTHER VOLATILE PETROLEUM PRODUCTS—Any industrial process involving the use of gasoline, benzine, naphtha, or other volatile petroleum products.

9. POISONING BY CARBON BISULPHIDE —Any industrial process involving the use of carbon bisulphide or its preparations or compounds.

10. POISONING BY WOOD ALCOHOL—Any industrial process involving the use of wood alcohol or its preparations.

11. INFECTION OR INFLAMMATION OF THE SKIN ON CONTACT SURFACES DUE TO OILS, CUTTING COMPOUNDS OR LUBRICANTS, DUST, LIQUIDS, FUMES, GASES OR VAPORS—Any industrial process involving the handling or use of oils, cutting compounds or lubricants, or involving contact with dust, liquids, fumes, gases or vapors.

12. EPITHELIOMA CANCER OR ULCERATION OF THE SKIN OR OF THE CORNEAL SURFACE OF THE EYE DUE TO CARBON, PITCH, TAR OR TARRY COMPOUNDS—Handling or industrial use of carbon, pitch or tarry compounds.

13. COMPRESSED AIR ILLNESS—Any industrial process carried on in compressed air.

14. CARBON DIOXIDE POISONING—Any process involving the evolution or resulting in the escape of carbon dioxide.

15. BRASS OR ZINC POISONING—Any process involving the manufacture, founding or refining of brass or the melting or smelting.

16. MANGANESE DIOXIDE POISONING —Any process involving the grinding or milling of manganese dioxide or the escape of manganese dioxide dust.

17. RADIUM POISONING—Any industrial process involving the use of radium and other radio active substances, in luminous paint.

18. TENOSYNOVITIS AND PREPATELLAR BURSITIS — Primary tenosynovitis characterized by a passive effusion or crepitus into the tendon sheath of the flexor or extensor muscles of the hand, due to frequently repetitive motions or vibration, or prepatellar bursitis due to continued pressure.

19. CHROME ULCERATION OF THE SKIN OR NASAL PASSAGES—Any industrial process involving the use of or direct contact with chromic acid or bichromates of ammonium, potassium or sodium or their preparations.

20. POTASSIUM CYANIDE POISONING —Any industrial process involving the

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use of or direct contact with potassium cyanide.

21. SULPHUR DIOXIDE POISONING—Any industrial process in which sulphur dioxide gas is evolved by the expansion of liquid sulphur dioxide.

22. SILICOSIS—Silicosis shall mean a disease of the lungs caused by breathing silica dust (silicon dioxide) producing fibrous nodules, distributed through the lungs and demonstrated by x-ray examination or by autopsy.

Periodic Health Examination in Industry

THE principle of the periodic health examination is neither new or revolutionary.* Fundamentally, it is merely a systematic attempt to secure earlier and more refined diagnoses for the purpose of hastening the discovery of preventable disease and to provide opportunity to correct adverse conditions of environment and faulty habits of living. which, if allowed to continue, so frequently become the basis of disease.

With the advent of the compensation plan for disability, of occupational disease laws, and the establishment of benefit plans, it has become necessary to distinguish between occupational and non-occupational disease. Its recognition depends upon the proper adaptation of pre-employment and periodic examinations by physicians, and the data obtained therefrom applied to the specific conditions of industrial exposure, both before and after disease occurs.

The progressiveness of any industry is largely determined by the application of all possible means and methods in the prevention and control of diseases due to occupational influence as well as non-occupational diseases. The employer suffers certain tangible losses such as increased labour turnover, increased spoilage of products, idle machines, increase of absenteeism due to disability and premature loss of experienced labour. Similarly, the insurance companies and Workmen's Compensation Boards must also face the financial contingencies. In many instances, the employee and his dependents may become a burden upon society because of permanent or temporary, partial or total disability, so that it is a social problem.

The first step in the reduction of such morbidity lies in prevention. This entails:

1. A more careful pre-employment examination;
2. Periodic health examinations at stated intervals determined by the particular industrial hazard;
3. A proper system of follow up for the correction of defects found;
4. Data so obtained must be recorded, tabulated and studied in order that we may appreciate the etiological factors and to correlate these with the clinical findings.

The pre-employment examination should be carried out by one who is familiar with the entire industrial process concerned. He must be able to appreciate the possibility of aggravation of defects or actual production of disease by exposure in the particular work to which the individual is to be assigned. In addition to personal susceptibility and idiosyncrasy, he must consider the elements of race, age, and sex in the occurrence of disease and injury.

The first contact between the company medical officer and the employee occurs at the pre-employment examination. It is desirable that their relationship should be one of trust and confidence. The examinee must be properly impressed with the thoroughness of the examination or he will not have much respect for subsequent periodic health examinations. The old method of putting a stethescope under his shirt and asking him to stick out his tongue must go. He should appear before the examiner without clothing. He should be asked a few kindly questions about his life and previous occupation, if any, to put him at his ease, and at the same time, it serves as a history record and gives an insight into his mentality and attitude toward his surroundings.

He should then be weighed, measured, and eyesight and hearing, speech, teeth, tonsils and nose examined. The examiner should have a definite routine system whereby he proceeds from the top of the head to the soles of the feet. It must be a systematic appraisal of the body as a whole followed by a consideration of individual systems. To be complete, it should include such laboratory procedures as urinalysis. Wassermann and blood examination if indicated. If there is to be any major exposure of the respiratory organs, then it is desirable to have an x-ray of the chest. Early tuberculosis and pre-employment silicosis are thus detected.

* W. E. LAMONT, M.D., and O. A. CANNON, M.B., F.A.C.S., Medical Officers, Steel Company of Canada Ltd, Hamilton, Ontario, in the *Bulletin* of the Ontario Medical Association, April, 1937.

THE BULLETIN

of

The American Association of Industrial Physicians and Surgeons

THE object of this Association shall be to foster the study and discussion of the problems peculiar to the practice of industrial medicine and surgery; to develop methods adapted to the conservation of health among workers in the industries; to promote a more general understanding of the purposes and results of the medical care of employees, and to unite into one organization members of the medical profession specializing in industrial medicine and surgery for the mutual advancement in the practice of their profession.

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OCCUPATIONAL DISEASES

The General Assembly of the State of Illinois has recently passed an Act, covering occupational diseases of Industrial employees. This Act is particularly concerned with diseases of the lungs, and poisoning from certain chemicals.

Under this new law it will be necessary for many industries to examine their present employees, and new employees, to determine their present health status and thereby prevent future liability.

We are a diagnostic laboratory, fully equipped to make x-ray examinations of the lungs, tests of the urine and blood for lead, and all examinations specified under the new law.

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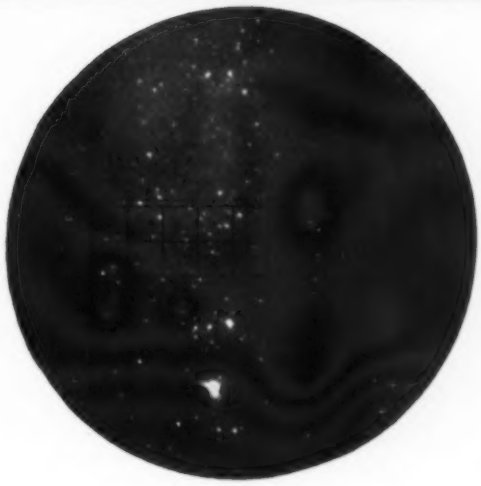

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The recent economic depression has made this examination doubly necessary. Many individuals have been suffering from malnutrition and, owing to straitened means, have not corrected such abnormalities as defective vision, teeth, tonsils and herniae. Roughly, four classes are determined:

1. Those fit for any type of work;
2. Those fit for special work;
3. Those temporarily unfit for work until some defect has been corrected;
4. Those permanently unfit for any work in the particular industry; fortunately, a very small group.

At the plant where we are employed, our system calls for a complete examination at the end of one year's employment for admission to the Benefit Society. Despite a rigid preemployment examination, a recent series of 719 cases of young adults revealed the following defects after one year of employment:

Abnormal Conditions Found	Percentage
Defective teeth and dental infection	66
Nasal abnormalities and infections	22
Gastro-intestinal disturbance	18
Defective vision	16
Diseased tonsils	12
Anemia	10
Hernia	8
Metabolic disturbance	4
Genito-urinary disturbance	4
Cardio-vascular lesions	3
Diseases of the lungs	3
Nervous disorders	2

Our program calls for the yearly examination of some 3,000 employees who have been included in the plant Benefit Society. We find that for the most part our men look forward to this examination, now that they realize it is being carried out strictly from a health standpoint and not as a weeding out process. The fact that treatment of abnormalities found is free from financial obligation has made our follow up relatively easy.

The examiner must be willing to listen to the recital of many trivial complaints, as it is so frequently from these apparently trivial symptoms that the serious affections of later years develop. He must bear in mind that the periodic health examination is a scientific examination of well persons to discover the precursors and the silent beginnings of disease which have no characteristic symptoms and are frequently unsuspected and unrecognized by the patient. Only a relatively small percentage of active workmen will be found actually suffering from advanced disease. It should give an estimate of the remaining physical assets as well as an interpretation of the signs and symptoms of already existing disease.

The examining physician should recognize the limit of his ability to examine special regions and it should be his duty to advise consultations with specialists where they are definitely indicated. The examiner should not, however, lean too heavily upon the shoulders of consultants but rather to use them in case of doubt to support, modify or amplify his own findings.

The ability of periodic health examinations to favorably influence morbidity and mortality has been

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1935 - 1936

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clearly demonstrated in our plant. Repeated physical examination has been carried out on 3,000 employees over the last eight years. It has proved an efficient means of improvig the general physical condition of our employees through the correction and elimination of defects. This has resulted in a marked lowering of benefits paid to employees and loss in wages sustained by them.

The following will serve to demonstrate some of the improvements. Prior to the inauguration of our campaign we had an average of 30 cases per year of peri-tonsillar abscess. This year, since the timely cases examined last year, we had removal of infected tonsils in the only two cases. Arthritis, lumbago and sciatica have shown a marked improvement since a special effort was made to lower the morbidity for this widespread disease. Patients with chronically infected sinuses are referred to our consulting specialist in ear, nose and throat in order that these foci may be eradicated. The result has been a reduction of more than 50% in our cases of arthritis, myositis and sciatica. Routine urinalysis has resulted in the discovery and control of eight cases of previously unsuspected diabetes. These are added to our list of known diabetics and are examined at intervals of not more than three months. Fifty-six cases of urinary infection were discovered and the patients put under treatment. Cardio - vascular diseases were an important item. Since the introduction of salt* in the prevention of heat cramps among our steel employees exposed to high temperatures, there has been an average increase of about 20 points points in systolic blood pressures among these workmen as compared with employees in other departments of our plant. Periodic examination of blood pressures frequently necessitates transferring employees from occupations at high temperatures to lower ones and less strenuous labour. The number of cardio-vascular patients under treatment has increased but the number of deaths from this cause below the age of 65 has actually decreased.

The early control of duodenal ulcer has been another gratifying result. Sixty-eight cases of proved ulcer were treated medically and all but four are now symptom free. Two perforated and required surgical intervention. The best results occur in the early discovered cases. Only one case of carcinoma of the stomach was encountered in the past two years, and it was too late for treatment.

Rectal examination is a necessary part of the health examination. Two cases of cancer of the rectum were discovered both relatively early during the past year. In each instance diagnosis could be made by the examining finger alone. Nine cases of marked hypertrophy of the prostate were found without positive urinary findings.

* In order to overcome heat prostration and heat cramps in employees subjected to high temperatures in our steel manufacturing, we have salt vendors placed at each drinking fountain. Salt is dispensed in the form of five-grain compressed tablets containing a small amount of starch with the ordinary table salt. Employees are instructed to take two tablets with each glass of cold water. During the extreme heat of July, 1936, we did not have a single case of heat cramps among employees who carried out these instructions.

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Due to the type of labour involved, herniae were extremely common. One hundred and forty-six cases were encountered of which 52 were stated by the patient to have been unsuspected. Forty-four cases were longstanding in elderly men and trusses were advised if not already being worn. The remainder have already been repaired or are awaiting operation.

The maintenance of proper eyesight is a necessary safeguard against accident, both for the workman himself and for his fellow employees. Two hundred and fifty cases of refractive error were discovered and referred to the consulting company eye specialist for proper fitting of glasses. In many instances, the need had been recognized, but the employee followed the usual procrastination habit until the necessity was pointed out to him.

One other aspect of the periodic health examination should not be neglected, namely, the opportunity to advise the examinee regarding the proper use of foods, clothing, ventilation, bathing and timely application of methods of immunization. Instruction in personal hygiene, habits of living and the modification and control of excesses should be given so that they may manage their lives more intelligently, more efficiently and more healthfully.

Finally, it cannot be over emphasized that, for beneficial results, the physician must, at the end of his examination, give specific instruction as to correction of disabilities. Vague or general suggestions are usually unheeded. Make definite appoint-

ments for treatments to start and consultations to be held, and see that they are kept.

Accident Proneness

IN THE course of an interesting article in *Personnel*, the quarterly journal of the American Management Association, various classes of accident prone people are described:

1. The persons with a marked hostility to authority;
2. The exhibitionist who is emotionally still a child with an insatiable craving for attention;
3. The day dreamer;
4. The person with well-developed self-destructive impulses.

These underlying trends are not susceptible to detection by tests and "can be brought to light only on the basis of a rather involved and extensive series of examinations and interviews."

Modern Management of Traumatic Surgery

AS THE hand of time goes around so must we medical men continually shift our methods of meeting and treating certain conditions of traumatic surgery.* Traumatic surgery is, no doubt, as old as man himself and dates back to the days of Adam and Eve in the Garden of Eden, which we are told in the Good Book was the beginning of man. But, as social progress makes its steps, so are we forced to meet new conditions.

We will speak largely of the local situation that confronts us here. However, it may be that these conditions are more or less universal since we, as doctors, are constantly meeting with more traumatic injuries than ever before. As our pioneers cleared this mighty forest there were occasional cotton gins and fewer saw mills constructed. Today, we have cotton gins, ground-hog saw mills, weed-saws and numerous types of farm machinery, many industrial machines, and we might add to these, certain types of gun-shot wounds and automobile injuries sufficient to round up a number of patients in every doctor's office.

We realize that in a short paper like this it would be impossible to describe in detail every kind of traumatic wound and its treatment. We will deal more particularly with lacerated wounds. These types of wounds are caused by the individual being caught in wood-saws and cotton gins, or where portions of the members are avulsed by a shotgun, or perhaps mangled in some farming machinery. Here, we not only have the conditions for the performance of some scientific, but also of conservatice surgery, and it is important that as many members of the hands, feet and arms be saved as possible.

In these types of injuries it has been our practice to control the hemorrhage as quickly as possible, cleanse the wound of foreign particles, mangled tissues and blood clots and do as little trimming of the ragged edges as possible. We never know which small bundle of tissue may have the

* F. L. Husband, M.D., Blytheville, Arkansas, read before the First Councilor District Medical Society, Paragould, October 15, 1936; published in *J. Arkansas Med. Soc.*, May, 1937.

The Industrial Doctor

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connecting length of our nerve supply or the small blood vessels we need and require for our budding process to rebuild the destroyed tissues. We dust in a large amount of neo-silvol crystals, and unless an unusually large lacerated wound exists, we simply close the wound by interrupted sutures, both the fascial structure and the skin. After an interval of 12 to 24 hours, if we have much exudate with suture tension we slip out one or more sutures and insert a small rubber drain; this gives times for solution of the neo-silvol crystals, which, in my opinion, provide the best known germicide for this particular type of injury. Obviously, all of these wounds are potentially infected. This allows contact with an antiseptic for 24 hours. Some fragments are infected and die from the lack of nerve and blood supply, consequently are lost to the part. However, even this procedure is more conservative than extensive debridement in the beginning with its chances of the loss of some tissue which might have remained viable.

Such lacerated wounds will often drain and heal as nearly by first intention as can be expected. In many of the avulsed types of injuries with certain contamination, infection follows with sloughing of the sutures a great deal of tissue with a profuse drainage. Such cases are advantageously handled by applying a voluminous dressing to the affected part and keeping it continuously damp by saturation with a hypertonic magnesium sulphate solution containing some alcohol and sufficient sodium bicarbonate to maintain alkalinity. The rationale in using such a solution is as follows: the magnesium sulphate acts as an external pulling agent against the blood stream and tissues and secondly, dilutes the exudate thus reducing its toxicity; the alcohol as an antiseptic agent, and lastly, the alkalinity, by changing the medium in which the organisms abound, since it is commonly known that infective organisms may be killed by simply changing the reaction of their medium.

In those cases with compound comminuted fracture, we are justified in assuming that osteomyelitis and periostitis will occur. Adequate drainage with irrigation in selected cases is the course to follow.

We have had a series of cases this past year wherein there was a great deal of disturbance to the bony structure, ranging from simple tears of the periostium to complete avulsion of whole parts of long bones. One case in particular was seen and treated in which the olecranon process of the ulna was shattered and a portion of the upper third of the ulna was missing. These cases were all treated with ultra-conservatism with attempts at saving the entire members with complete recovery and good function in the majority of the cases. A more radical surgeon most probably would have amputated in several of these instances. I think we have saved several permanent disabilities by conservatism and allowing nature to do her part. We have tried this procedure, not once, but in a series of cases, and find that it serves our purpose in the type of surgery which daily confronts every doctor in this territory.

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Each case, after being dressed, should be placed at absolute rest by immobilization and should receive 1500 units of antitetanic serum.

We notice in those cases wherein hands are caught in gin saws that we often have a low grade infection characterized by a bluish serum exudate with a slight destruction of the epidermis around the wound edges. This we believe is a mixed infection containing vibrion septique organisms. We have found that this mild infection responds readily to application of 2% picric acid.

We conclude by summarizing our accepted method of treatment:

1. Cleasing the wound thoroughly as possible without damage.
2. Using conservatism in trimming the edges and surrounding tissue.
3. Filling the wound with neo-silvol crystals.
4. In minor wounds closing primarily with later drainage if inflammatory exudate demands it by slipping sutures and rubber drainage. The major wounds are primarily drained.
5. Applications of hot hypertonic solutions.
6. Administration of prophylactic antitetanic serum.
7. Immobilization.

Sulfanilamide

THAT para-amino-benzene-sulfonamide is an effective and specific agent in controlling infections caused by hemolytic streptococci has been the subject of several medical jour-

* *Nebraska State M. J.*, April, 1937.

nal papers which have appeared in this country and abroad.* It has been proclaimed as the greatest contribution to chemo-therapy since Ehrlich's discovery of arsphenamine.

The Squibb Laboratories have made available five-grain tablets of para-amino-benzene-sulfonamide under the name SULFANILAMIDE — a name suggested by the Council on Pharmacy and Chemistry, A. M. A.

Sulfanilamide is given orally. It is indicated in treatment of puerperal fever; post-abortion septicemia; erysipelas; complications of scarlet fever; influenza; nasal, post-nasal and throat involvements of hemolytic streptococcal origin, including septic sore throat, otitis media, cellulitis, and perhaps also in pneumonia and cerebro-spinal meningitis. Initial dosage is three tablets every four hours, for one day or longer, depending upon the patient's condition. The dose may then be reduced to one tablet every four hours until recovery.

Report on Medical Economics

THE report of the Committee on Medical Economics was read by Dr. J. C. Vinson, as follows:*

I. The Committee on Medical Economics respectfully calls to your attention the fact that the individual income in the United States is less than $250.00 a year and that the income of each family is less than $1,100 a year; that during the height of prosperity in the United States 50% of the individuals were not financially able to obtain adequate surgical and medical care. The Committee respectfully calls to your attention the program that is being inaugurated as incorporated in the Social Security Act. Your attention is called to the fact the program for syphilis alone involves approximately one-sixth of the population of the United States. This is only one of the many programs being initiated. You are aware that the treatment of veterans of every war has also eliminated this class from the private practice of medicine.

II. The recent economic survey made by your committee leads to the following conclusions:

a. The individual doctor realizes impending disaster and views the situation with a fatalistic mental attitude.

b. The county medical society as a unit of organized medicine has been totally useless in protecting the doctor or the public.

c. The state organization has beautifully impressed its inefficiency upon the public at large by a strict denial of any change in the practice of medicine as a whole.

d. The national leadership of medicine has developed no collective cohesive solution to the ripening process of a problem as old as organized medicine.

e. Organized medicine has denied its members the result of medico-economic laboratories that have and could be established through philanthropic grants.

f. The practice of medicine as it has existed in the past is over. The mental attitude of the individual doctor must undergo a radical change. The individual medical activity must be welded with collective groups for the greater security of the whole.

* From the Proceedings of the Sixty-Fourth Annual Meeting of the Florida Medical Association, as published in *J. Florida Med. Assoc.*, April, 1937.

The Association for the Advancement of Industrial Medicine and Surgery

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Blanket Coverage

FOLLOWING is a summary of an interesting recent publication, "Some Aspects of Blanket Coverage of Occupational Diseases in the United States, in U. S. Public Health Service, Public Health Reports, March 19, 1937, p. 329-334:

1. The workmen's compensation laws of the different states are not uniform.

2. Eight states have blanket coverage—California, Connecticut, Illinois, Massachusetts, Missouri, New York, North Dakota and Wisconsin. In addition, blanket coverage is provided by three Federal laws.

DUST IN INDUSTRY — What the hazards are; how to determine their existence; how to combat them.

INDUSTRIAL DUST

Hygienic Significance, Measurement and Control

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This book covers the problem of dust control in its relation to the health of workmen, emphasizing the cooperative nature of the problem both for physicians and engineers, and presenting principles, methods and data for the design and operation of dust-control equipment. It discusses the physical aspects of dust and fume suspensions and their effect upon man; the analysis, measurement, and microscopy of fine dusts; and the practical control of dusts and use of respiratory protective devices.

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3. The question of whether a schedule or blanket coverage shall be adopted is controversial.

4. Casualty insurance rate makers report that a change from no coverage to blanket coverage, in the case of a state with compensation laws but without occupational disease coverage, means not more than 1% increase in the rates.

5. Opponents of complete coverage state that with laws having no schedules the advantage of prompt payment of compensation is often lost.

6. Excerpts from the Wisconsin law pertaining to occupational disease are presented.

7. Some results of blanket coverage for Wisconsin are given and in some instances compared with data published by the United States Employees' Compensation Commission.

Occupational Disease Disability Legislation

COMPENSATION for occupational diseases has been one of the most prominent subjects before State legislatures this year.* Bills on some phase of the subject have been introduced in 23 legislatures. Laws have been enacted in Indiana and Washington, and bills have passed the legislature but have not yet received the governor's approval in Delaware, Nebraska, Ohio and Rhode Island. Idaho, Maine, Montana, and Oregon have provided for committees to study the problem, and Idaho and Montana have each appropriated $5,000 for the purpose. New York has amended its law to provide for funeral expenses in silicosis cases.

The Indiana law is modelled on the Illinois law of 1936, and provides for elective coverage, leaving the employer who does not elect liable to damage suits for a maximum of $10,000 with common law defenses abrogated, provided negligence can be proved; violation of the State law constitutes negligence. The act applies to occupational disease arising out of and in the course of employment, and a detailed compensation schedule is provided, including double compensation for illegally-employed minors. Disablement must occur within a year after last exposure, except in the case of silicosis or asbestosis, when the period is three years, and death must occur within one year of disablement. Workmen with nondisabling silicosis or asbestosis may, with the approval of the Board, waive 50% of compensation due to disablement resulting from further exposure. Substitute compensation systems, equivalent to the benefits provided by the law, are permitted on approval. The act is to be administered by the Industrial Board.

Washington has adopted coverage for a schedule of occupational diseases, including dust diseases, provided the claimant has been employed in the State for three years immediately preceding and has had a substantial exposure to conditions peculiarly conducive to the disease contracted. However, the cost of such coverage is to be borne equally by employer and employee.

Delaware sent to the Governor a bill which originally provided for

* From "Survey of Labor Law Administration, Division of Labor Statistics, U. S. Department of Labor, May, 1937.

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general coverage, but which was amended to provide for a short occupational disease schedule.

In Nebraska, the legislature has passed a bill including any occupational disease contracted in battery manufacturing plants among those to be compensated.

In Rhode Island, the senate and house have passed a bill providing limited compensation payments for total disability due to silicosis or asbestosis.

In Ohio, silicosis has been added to the schedule of compensable diseases, and benefits are payable for total disability or death.

Bills providing for general or scheduled coverage are still pending in Michigan, Pennsylvania and Tennessee; bills providing for coverage of silicosis only are pending in California and New Jersey; and Illinois and Wisconsin are considering amendments to existing laws. A bill providing for an occupational disease study is still before the legislature in Massachusetts.

Syphilis—Its Ramifications

HAVING done syphilis therapy, at Graves Dispensary, Los Angeles, a charity clinic conducted by the University of California, for a period of six years—in entire charge of this therapy for two years—also treating thousands of cases for Los Angeles County, I feel qualified to lay down certain pronouncements upon the subject.*

I try never to let a patient stop treatment short of 72 bismuth and 32 neosalvarsan injections. Otherwise he may regret it in after years and curse me for negligence. Foreign protein is an important adjunct in treatment.

* GARDNER S. CHAPIN, M.D., Hollywood, California, in *Southwestern Medicine*, March, 1937.

SUPPLEMENTARY INFORMATION

A POSTCARD addressed to Industrial Medicine with your name, and the number as below, or—YOUR LETTERHEAD sent to Industrial Medicine with the number, as below, will bring you the article, reprint, pamphlet, description, or catalog, so designated:

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6-800 Protamine Zino Insulin (its application and limitations)
7-800 Solargentum (a mild protein silver)
8-800 Tetanus Antitoxin
9-800 Tetanus Gas Gangrene Antitoxin Combined
10-800 Typhoid Vaccine —E. R. Squibb & Sons
1-700 The Fluoradex Family —Westinghouse X-Ray Co., Inc.

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I do not give rest periods in cases of less than 28 years duration. They are a relic of the time when we nearly killed our patients with mercury and potassium iodide, and had to "let them come up for air."

If bismuth stomatitis appears, I cut the next dose one-half and then increase gradually. Frequently a patient's tolerance builds up while under treatment and permits full doses. If he vomits after the arsenical I do likewise, reducing the dose and build up gradually.

I always cut the first dose of a course of neosalvarsan to one-half and am sure that patient's stomach is empty for six hours before and six hours after an injection.

I treat heart cases moderately and gently, using small doses only, especially of arsenicals if they are used at all.

The dentist's grinder can do wonders on a set of Hutchinson teeth and promptly builds up the patient's morale.

On eye cases, for the past four years, I have used only bismuth, mercury, and foreign protein, arresting the process in every case. Before this period, using arsenicals, I lost many cases.

If an arsenical dermatitis appears, I give that patient no more arsenicals.

I have seen x-rays of the buttocks taken six months after administration of bismuth salicylate in oil with the metal still plainly visible. There nevertheless is absorption in this method or otherwise we would never have black lines on the gums. With this salt injected into the tissues the patient gets continuous treatment. If he temporarily lapses in his visits, he still gets continuous treatment, and to my mind this salt is better than a soluble salt. At any rate I have seen less recurrences on intermittently treated cases with the salicylate than with soluble salts.

The trained sense of touch is a valuable acquisition. One should be able with ease to trace in a fat forearm, the veins from the elbow to the wrist. This sense comes suddenly—quicker to some than to others. If you haven't it cultivate it and it may surprise you how quickly it will come to you. For intravenous work it is far ahead of sight.

A 23 gauge one-inch needle with a hand syringe requires much more pressure on the plunger (injecting slowly) to inject when the needle is outside the vein than when it is in. One should be aware instantly if the needle has slipped out of the vein or has not entered it, and there is absolutely no excuse to give the patient a bad burn—more than a fraction of a drop, with this needle. A smaller needle feels the same on the plunger whether it is in the vein or outside of it. I use a short bevel needle; there is less chance of its being half in and half out of the vein.

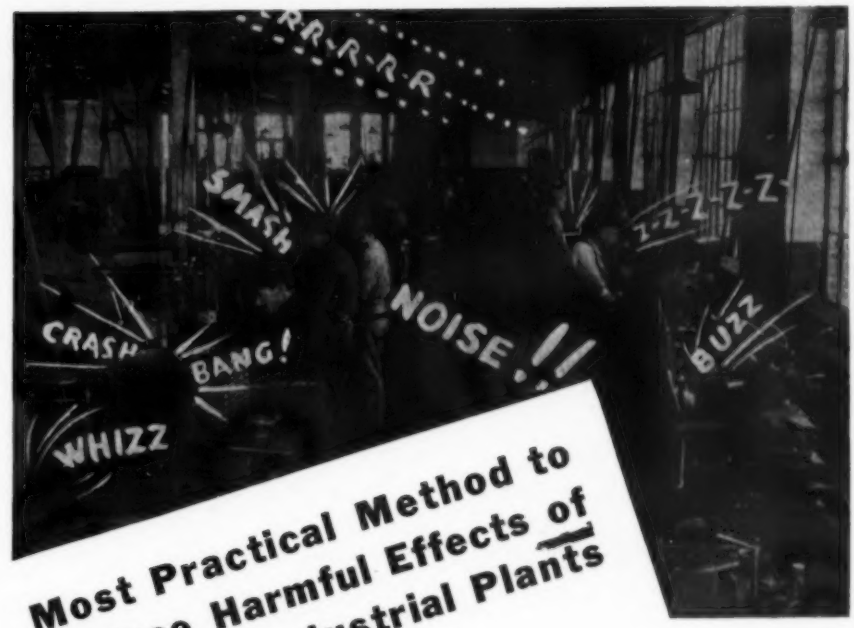
It should be possible to manufacture a needle, oval in cross section instead of round. Then if a short bevel were put across the long way of the oval, the opening would be round and provide a minimum chance of being within and without the vein. If a flat wire were supplied with these needles they could be easily cleaned.

If one has among his clientele a family with a backward child he should examine it carefully for a luetic taint. Syphilis simulates all diseases.

Recently a case dropped into the office with a recurrent chancre and a secondary efflorescence. The history was that his family physician had given him six doses of neosalvarsen with complete healing of the chancre. The final instructions were that if the sore recurred, to apply a little antiseptic powder and forget it. Are there still such M. D.'s? Should the ethics of our profession protect such men?

The last innocent I contacted came in with a leg ulcer that wouldn't heal. It had existed five weeks in spite of treatment by two doctors who failed to take his Wassermann. His Wassermann came back 1 plus but he knew he "just couldn't have syphilis" so he went to another doctor who told him 1 plus didn't count, not even 2 or 3 plus, but if it were 4 he might require a little treatment—18 or 20 "shots." At last reports he still has his ulcer. The pity is he has a wife and two small children.

CASE REPORTS ILLUSTRATING COMPLICATIONS: A woman 28, weight 138, had had 15 injections of neosalvarsan —.45 gm. at weekly intervals. For the 16th—last of the second series—she came in one day late. Her stomach was empty and nothing out of the ordinary was noticed during the injection. Thirty seconds afterward she slumped forward, respiration ceased, and no heart sounds were audible. For the next minute she became gradually more cyanotic — still no respiration nor heart action.



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Fifteen m. of adrenalin 1/1000 were given intravenously. After 30 seconds there was a deep inspiration and a bright red petechial rash appeared over the body which disappeared on pressure. Sphincters were relaxed. After a short interval respiration became regular and the rash faded away. Recovery was uneventful except for severe gastric pain and vomiting. This patient reached a negative Wassermann on bismuth and foreign protein. Adrenalin is always handy in the office and bag.

A man came to the office complaining of failing vision—20/200 in each eye; he stated they had been getting progressively worse for the past two years, that he had been to five doctors who had told him he had optic atrophy and that they had taken his Wassermann which was negative in each case. Following my usual custom in venereal disease of disregarding statements by the patients, I took a Wasserman and it came back 4 plus. The patient then admitted he had lied about the other doctors because he thought the Wassermann was not necessary, believing he couldn't have syphilis. This patient, after having only 18 injections of bismuth salicylate in oil, 1 gr. ea. has a vision 29/38.4 in each eye. According to my experience this patient should not be treated with an arsenical.

A man, on bismuth and neosalvarsan, after the sixth injection of neosalvarsan developed a mild case of arsenical dermatitis and was immediately taken off neosalvarsan and given sodium thiosulphate; he continued on bismuth but had very low tolerance, there being a bismuth stomatitis on only 1/2 gr. per week. After 12 injections he returned to the clinic with what appeared to be a deposit of metallic bismuth in the skin all over the body. The areas were scattered and ran in size from that of a pea to that of a dollar, round and slate black in color. He was taken off bismuth and put on mercury and potassium iodide, and when last seen six months later, the black spots were fading though still in evidence.

A woman on bismuth and neosalvarsan after the third injection of neosalvarsan developed an arsenical dermatitis—a red pin point rash over the entire body accompanied by intense itching. I advised her of the possible results of another injection and took her off neosalvarsan. Nevertheless she went to another doctor and took another injection of neosalcarsan. She practically exploded with an exfoliative dermatitis, dying six weeks later.

A female sypilophobiac came to the clinic and had six Wassermanns in six weeks, all negative, but was not satisfied. She went to one of the advertising gentry and got a positive Wassermann out of the back room in five minutes. They found her body in the surf at Venice the next morning. Had this women been given a spinal Wassermann she probably would have been salvaged. I find a spinal usually convinces these cases.

Syphilis is not the severe entity it was 35 years ago. We now seldom see the terribly malignant cases. The milder forms are much more in evidence. At the tail end of a smallpox epidemic we see cases which we know are smallpox. The entire train of symptoms are there except there are no pustules. Perhaps that is why we sometimes see active cases of syphilis with negative serology. In such cases a therapeutic test of 30 days' intensive treatment may put one on the right track.

A national law requiring a yearly Wasesrmann on all citizens would accomplish as much for our race as vaccination against smallpox.

Is there a sphyilis reservor in some form of food? Why is syphilis more prevalent among food handlers than in any other group except negroes and prostitutes? Osler said, "If he's a Greek, give him a Wassermann, if he's a waiter give him a shot."

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Research Progress

THE preventive engineering study (of Mellon Institute) dealing with "Measurement and Control of Industrial Dust," was directed by Philip Drinker, of the Harvard School of Public Health, chairman of the foundation's preventive engineering committee.* This report advises that engineering, in seeking to curb the health hazards of the "dusty trades," should center its control efforts on the smallest dust particles, those that can be breathed and retained in the lungs of workmen. The study, reviewing the engineering aspects of industrial disease problems, informs industry that, as a matter of protection, the engineer will be well advised not to let men breathe heavy concentrations of any material. It points out that, if no other reason for dust control can be found, there are the transcripts of some recent suits at common law in which fantastic damages for alleged silicosis were granted to men who breathed dust containing little or no silica. Courts and compensation boards are not impressed by subtle distinctions between dusts of 10 or 40% silica content. Men working in dusty trades suffer far more from respiratory troubles of all kinds than do men who work in clean air. The evidence that excessive dustiness of any kind is harmful is beyond argument. Incidentally, a clean place induces better work by all. The report terms it folly to "split hairs" over the fixing of a precise limit for safe dustiness in industrial workings, asserting "if it looks dusty it is too dusty." Engineers are urged to dispose of dust below the figures usually prescribed, in order to protect industry and labor to the practical limit.

The report of the foundation's medical committee, of which a medical specialist, A. J. Lanza, is chairman, has just been issued. This is the third of three major "inventory" studies undertaken as pre-requisites to the drawing of the foundation's research program. The report, a world review and evaluation of "Silicosis and Allied Disorders," represents a necessary step toward coping with occupational disease. It concludes that, on the basis of present knowledge, nine points are definitely known regarding silicosis. These are described in detail. There is then outlined a health control program for the guidance of employers, as follows:

A practical program of pre-employment examination of all workers exposed to dust containing silica is essential. Such examinations should include a complete physical examination of each individual, a careful history of past occupational exposure to dust, and a chest roentgenogram (x-ray).

The value of such procedure may be summarized thus:

1. Protection of prospective employees, who may have diseased lungs, from silica exposure.

2. Discovery of hazardous jobs, as a result of finding the silicosis cases, in order to eradicate these hazards.

3. Discovery of active and open cases of tuberculosis which are in contact with other employees, especially protecting the younger workers who are susceptible to contact infection.

4. Discovery, through periodic examination of those with inactive tuberculosis, of any reactivation of their tuberculosis, so as to protect especially the younger employees. This also offers the infected individual a better chance of cure.

5. Discovery of early cases of silicosis through periodic examination, in order to give added protection from further excessive dust exposure.

6. Determination, through periodic physical examination, of the effectiveness of the dust control program.

In recommending projects for medical research, the report states:

There is no phase of employee health which concerns the employer more than does the question of dust diseases, and the ever-increasing extent to which the employee's health is being made a responsibility of the employer demands that every available opportunity for increasing our knowledge be explored.

The following research projects are recommended to the foundation:

(A) Relationship between silicosis and tuberculosis. (B) The effect of other substances upon the action of silica in the body. It is claimed that some substances retard the action of silica on the lungs and that others seem to hasten the silica action. (C) Study of the mechanism by which silica exerts its injurious effects upon the body. Various explanations have been offered, such as that the silica acts physically, or that the action is chemical or physico-chemical. (D) Research in the technic of roentgenography. As it appears that to an ever-increasing extent pre-employment medical examinations will include chest roentgenograms, a man may be hired or rejected on the basis of his x-ray film. Therefore, the very best technic that can be evolved is the least with which industry can be satisfied.

* From an article in *Indust. & Eng. Chem.*, April 10, 1937.

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